Botany.

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been built upon the south side of Beacon Hill. The lower part is constructed in a plain and simple style of architecture, with red brick. The extent of the front is 173 feet, and over the centre rises a spacious dome, terminated by a circular lantern, 100 feet above the foundation. The prospect from this is magnificent, surpassing everything else of the kind perhaps in the United States. The town, with its numerous buildings, the harbour, islands, shipping, a fine country interspersed with villas, and about twenty flourishing towns, are to be seen here. Other important improvements have also been executed. On the south side of State Street, stands a very lofty and extensive hotel, under the direction of one of the principal merchants in the town. The house is seven stories high, and occupies a large extent of ground.

An extensive range of lofty warehouses has been erected upon India wharf: they are built of red brick, with much neatness and uniformity. Offices for the merchants are below, and the upper part of the building is appropriated to the reception of goods. A short distance from these warehouses, to the northward, is Long Wharf, or Boston Pier, which extends from the bottom of State Street, upwards of 1750 feet into the harbour. Its breadth is above 104 feet. On the north side of this wharf is a range of large warehouses, extending the whole length of the pier. Most of the old buildings have been pulled down, and handsome warehouses, similar to those on India Wharf, erected on their sites. The ground floors of these warehouses are occupied by wholesale or retail stores, merchants' offices, &c. The upper parts are appropriated to the warehousing of goods. At the end of this pier there are upwards of seventeen feet of water at ebb tide.

Boston, West, contains the dwelling houses of the principal merchants. A number of elegant buildings have been erected here within these few years, and wide spacious streets, consisting of handsome private houses, are still forming throughout that end of the town. Boston is well paved, and has excellent foot-paths of flagstones. The markets are situated near each other, close to the water side, and are supplied with every description of provisions in the greatest plenty. Besides its connexion with Charlestown, it is also united by a bridge 3,840 feet long, with the town of Cambridge; both bridges are kept in good order by the produce of a cent. toll. The population, in 1800, was 24,937; in 1820, 43,000. It is 252 miles north-east of New York; 347 north-east of Philadelphia, and 500 north-east of Washington

Boston (Thomas), a pious divine of the church of Scotland, who flourished about the end of the seventeenth century. He wrote many books on divinity, which were long extremely popular. Among these, his illustration of the Assembly's Catechism, his Treatise on the Covenant, his Human Nature in its fourfold State, and his Crook in the Lot, have gone through a vast number of editions.

BOSTRICHUS, in entomology, a genus of coleopterous insects, whose distinguishing characters are the antenna clavated, the club solid; thorax convex, with a slight margin; head inflected, and concealed under the thorax.

BOSWELL (James, Esq.) of Auchinleck, the son of the Hon. Alexander Boswell, lord Auchinleck, was born at Auchinleck in 1740, and studied the civil law at Edinburgh. In 1760 he visited London, for which place he ever retained a partiality; and was desirous, at this period, of a commission in the guards; but was withheld by parental authority. In 1763 he went to Utrecht, and proceeded through Switzerland to Italy, where he contracted an intimacy with Paoli of Corsica. He returned to Scotland in 1766, and, being admitted an advocate, was employed in the celebrated Douglas cause, the particulars of which he published in a pamphlet. In 1768 he printed An Account of Corsica, of which Dr. Johnson spoke in high terms. The year following he married Miss Mary Montgomery, his cousin, who, at her death in 1790, left him two sons and three daughters. In 1782 he lost his father, on which he removed to London, with a view to professional practice, but never succeeded; the only appointment he obtained was that of recorder of Carlisle. In 1785 he published A Journal of a Tour to the Hebrides, which met with a favorable reception; as likewise did his more important work, The Life of Samuel Johnson, LL.D. which appeared in 1790, in 2 vols. 4to, and forms one of the most exquisite and amusing delineations of character in our language. Mr. Boswell was also the author of Two Letters to the People of Scotland, printed in 1783; the Hypochondriac, a series of papers in the London Magazine, and several Miscellaneous Pieces in various periodical publications. He died in London in 1795.

BOSWORTH, a market town of Leicestershire, on a high hill, memorable for the decisive battle fought near it between Richard III. and the earl of Richmond, afterwards Henry VII. The church is spacious, with a very beautiful spire. Various fragments of sundry lances, &c. are shown as having been ploughed up at Redmore or Bosworth Field. It has a market on Wednesday, and fairs May 8th, and June 10th. It is 13 miles north-east of Leicester, and 106 N.N.W. of London. Long. 1° 18′ W., lat. 52′ 40° N.

BOTAGIUM, in middle age writers, a fee paid for wine sold in butts.

BOTALE Foramen, in anatomy, an aperture in the heart of a fœtus, whereby the blood circulates, without going into the lungs, or the left ventricle of the heart.

BOTALLUS (Leonard), physician to the duke of Alençon, and to Henry III. was born at Asti in Piedmont. He introduced at Paris the practice of blood-letting, which was condemned by the faculty; though soon after his death it came into rather too general practice. He wrote, 1. De Curandis Vulneribus Sclopetorum, 1560, 8vo. 2. Commentarioli duo, alter de Medici, alter de Ægroti, Munere, 8vo. 3. De Curatione per Sanguinis Missione, 1583, 8vo. His works were collected and published at Leyden in the year 1660.

BOTANY.

BOT'ANY, Bot'anist, Botan'ical, Botan'ick, Botanol'ogy. } Gr. βοτανη, a herb, herbage; relating to herbs; skilled in herbs; a part of natural history which relates to vegetables; the science of plants. Botanist, one who studies the various species of plants. Botanology, an oration or discourse upon plants.

Some *botanical* criticks tell us, the poets have not rightly followed the traditions of antiquity, in metamorphosing the sisters of Phaeton into poplars. *Addison.*

The uliginous lacteous matter, taken notice of by that diligent *botanist*, was only a collection of corals. *Woodward.*

Then spring the living herbs, beyond the power
Of *botanist* to number up their tribes. *Thomson.*

While *botanists*, all cold to smiles and dimpling,
Forsake the fair, and patiently—go simpling. *Goldsmith.*

1. Botany, considered in its details, treats of the elements, of the immediate principles, of the internal and external structure, of the functions, of the organs, and of the similitudes and dissimilitudes of the almost infinite multitude of beings of which the vegetable world is composed.

2. Chemistry explains the constituent elements and the immediate principles of vegetables; anatomy and physiology indicate the structure of their system and the uses of their parts; botany, properly so called, teaches us to compare, to describe, and to name plants, and to class them according to the mutual affinities which are indicated by their external characters.

3. In this article it is not proposed to enter into any investigation of chemical botany, which has no practical relation to the study of the science, and which more properly forms a part of the science of chemistry. The heads into which the following remarks will be divided are, 1. The analogy of the science; or of the differences which exist between vegetables and other animated beings, and of their resemblances. 2. The history of the science. 3. The anatomy and physiology of plants. 4. Pure botany, comprehending the theory and principles of the science, its terminology, and its classifications.

I. Of the Analogy of the Science.

4. Among the multitude of beings which cover the surface of our planet, man only is possessed of the intellect which raises him above other animals. The latter are the mere slaves of their feelings, or of instinct; but man, whose only laws act upon his own free will, by the operations of the mind, is divested of the mere sense of necessity or of want, and directs his intelligence to the examination and knowledge of the other beings which constitute that glorious nature which has been formed for his advantage. The infinite variety of forms, and the imposing appearance of those objects which surround him, not only offer him matter for admiration, but carry him yet further; he is induced to study the laws by which they act or live, the qualities, whether useful or injurious, which they possess, and the affinities which they bear to himself and to each other. God, mind, and matter, are the subjects of the meditation of man. But if he would devote himself to all the departments of knowledge, which are included under these three great names, his natural weakness would compel his mind to sink under the exertion.

5. Hence the origin of sciences, into which all nature is divided by certain limits. By the aid of analysis, the fruit of intellectual observation, all knowledge is separated into different branches; and though the boundaries of the sciences are confined in appearance, that limitation has been the means by which each has been brought to its present state of perfection, and by which the knowledge of one science has been made to bear upon that of another.

6. On the one hand, intellect has given rise to what are called the intellectual or moral sciences; on the other hand, observation has created the natural or physical sciences; and these are divisible under three heads, that is to say, Physics, medically considered, Chemistry, and Natural History. The physician directs his attention to the properties and maladies of matter in general; the chemist considers the action of its elements; and the naturalist studies the phenomena of particular parts.

7. The district of the naturalist is confined to what are called the three kingdoms of nature; and no limits can appear more certain or decided than those within which these kingdoms are confined. The *mineral* kingdom is composed of brute matter, and is only susceptible of increase, by the juxta-position of the substances which combine in its formation. *Vegetables* are furnished with organs, by means of which they assimilate and adapt to their purposes the elements which surround them; but, fixed by the hand of nature to one spot, they are incapable of other movements than those which are peculiar to their organisation, or than those which are communicated by neighbouring bodies. But *animals* which are endued with similar properties in many respects, and which are propagated in like manner by peculiar organs, are also furnished with instinct, which teaches them how to distinguish their aliment, and to move from place to place. But do these limits absolutely exist in nature, or are they the imperfect creatures of the mind of man? And is not all nature connected by an inconceivable and inextricable multitude of affinities, crossing and interlacing each other in all directions, in such a manner as to render it impossible for us to circumscribe any one of her works within bounds so absolute that she will not be found overleaping them in some corner or another? It will probably be found that the affirmative is the answer to these suggestions, and that the deeper becomes our knowledge of the productions which occupy our minds, the more numerous the exceptions will be found to every law by which man in his ingenuity has

fancied that he has fettered those operations of nature from which his own existence has been derived.

8. What, for example, is a vegetable? This word is in every body's mouth, and yet no one has hitherto been able to define it in so exact a way as to fix the certain line by which the vegetable is to be distinguished from the animal. In this respect men of science are not to be separated from the multitude, except that they have acquired the habit of doubting, to which they have been conducted by study and meditation.

9. The division of minerals, vegetables, and animals, already spoken of, has been long admitted; and if we judge only by our first impressions, the distinction is not to be shaken. There is certainly something imposing in that simple manner of regarding the works of the creation; but, if we think upon it scrupulously, we shall be at no loss to perceive that it cannot be applied with precision, as we have no means of ascertaining at what particular point either sensation or sensibility cease to exist.

10. For this reason many modern philosophers reject the division of the three kingdoms, and admit only two great classes, of organic and inorganic substances. The latter class embraces all brute matter; fluids, gas, minerals. The moleculæ of which these are composed are subject to the laws of chemistry, physics, and mechanics. The other class includes animals and vegetables; their constituent moleculæ are in a perpetual state of motion. The organised particles of which these moleculæ are constituted are irritable, that is to say, susceptible of contraction, upon the application of particular stimulants; a wonderful power, the effects of which we are daily called upon to admire, but the first cause of which, like all other first causes, is beyond the perception of the human mind, and is designated by the appellation of the vital principle.

11. Endowed with this power, an organic body is able to offer resistance to such external causes as are prejudicial to it, to reject such substances as are useless or hurtful, to select those which are best adapted to its nature, to associate and dispose them according to the laws of its peculiar organisation, to communicate to them the motion which animates its moleculæ, to increase in volume, and finally to reproduce other beings of the same nature as itself. In the opinion of an ingenious Frenchman, the process of generation and nutrition, rightly considered, are two modifications of one and the same phenomenon. It is, therefore, irritability which distinguishes to our perception animals and vegetables from brute matter. But if irritability is absent, no fixed line of demarcation can be assigned.

12. Brute matter is formed by the attractive power of its elements. Organic bodies owe their existence to beings of their own kind. The first ceases to exist whenever the powers of chemistry or mechanics become greater than those by which the aggregation of the moleculæ of matter is maintained. The second perish when the organs accessary to their existence lose their irritability.

13. The limits of organic and inorganic bodies may, therefore, be considered to be ascertained with tolerable, if not with rigid, precision. The differences between vegetables and animals must now occupy our attention. A glance at the peculiarities of each will show in what these differences consist.

14. If we cast our eyes only upon the higher orders of plants and animals, in which organisation is in its highest state of perfection and development, no difficulty will be found in perceiving how wide a difference reigns between them. But in the lower orders of each, these differences vanish away. We will consider the connexion of animals and vegetables, both in their most perfect and most imperfect state.

15. And, firstly, their most perfect state of organisation. Carbon, oxygen, hydrogen, and occasionally azote, constitute the basis of vegetables. Occasionally metallic oxides, and some alkalies and earths are found also, but they exist in very minute quantities, and cannot be said to form any part of the peculiar character of vegetables. Animal matter offers the same compound; but differs remarkably in this, that while carbon is in excess in vegetables, azote is in excess in animals. A vegetable is wholly composed of an homogeneous, transparent, flexible, colorless substance, forming a mass, in which, by the aid of powerful microscopes, we are able to detect no other organisation than what is caused by the cohesion of an infinite multitude of tubes or cells, of various conformation. In animals, the structure is far more complex. Three organic elements enter into their composition. The first is the cellular tissue, which is a mass of membranous and continuous cellules, the cavities of which communicate with each other through pits or perforations in their sides; the second is the irritable fibre, consisting of long filaments, evidently possessing a power of contraction, composing the muscles by their union, and lining the arterial tubes and the intestinal canal; the third is the medullary substance; an homogeneous pulp, which presents to the eye, when examined through a microscope, a conglomeration of minute globules. The brain, the spinal marrow, and the nerves, are composed of this substance. Animals are furnished with an intestinal canal, usually open at each extremity. One orifice is for receiving aliment, the other for voiding that part of the food which is useless for nutrition. The intestinal canal is furnished, for a part of its length, with pores, which absorb the nutritive moleculæ, and throw them into 'the torrent of circulation.' Plants have no intestinal canal, and their absorbent pores are diffused over all parts of their surface. For this reason, Aristotle and Boerhaave designated plants by the title of animals turned inside out.

16. But, if we consider the distinctions between those animals and vegetable substances which are imperfect in the greatest degree, we shall find that nearly all these discrepancies are non-existent. The infusorial animalculæ are, for the most part, formed with nothing more than an intestinal canal, with two foramina; or, as a well-known writer has observed, they are all stomach. Among plants, the genera Palmella, Echimella,

Protococcus, and many others, possess the same simplicity of anatomical structure. The power of motion, which is believed to be the peculiar attribute of animals, equally exists in the genus Oscillatoria of vegetables. The propagation of the polype, by separation into many parts, is precisely the mode of increase which takes place in many Confervæ. As to the distinction of irritability in animals, and non-irritability in vegetable bodies, it is one of those problems which, perhaps, will never be solved. That the presence of nervous and muscular fibre is not essential to even animal irritability, as some have supposed, is obvious from the infusoria, in which neither muscle nor nerve exist, and which are, notwithstanding, endued with irritability. It is probable that every organic body, which possesses the capability of development, is, from that circumstance alone, irritable, although the power of contraction may not be always manifest; for nutrition, or the power of assimilating foreign substances, and incorporating new moleculæ with themselves, which living beings possess, and of subjecting them to the laws of organisation, of necessity supposes a force of suction which attracts the nutritious juices. But how is suction to take place otherwise than by the alternate contraction and expansion of the absorbent vessels? The phenomena of nutrition are, therefore, a proof of irritability; and since plants increase, it is clear that they possess powers of nutrition, and consequently are irritable. Besides which, many exhibit motions, as in the Oscillatoria, above alluded to, and in the common sensitive plant, which cannot be explained upon the ordinary laws of physics, and which may be supposed to result from a power of contraction, of what may be called the muscular fibre.

17. Plants are operated upon in the same way as animals, by the application of poisonous or corrosive substances.

18. M. F. Marcet, of Geneva, has lately published the result of some curious experiments respecting the effect of both mineral and vegetable poisons upon the system of vegetables. His observations were chiefly made upon the common kidney bean (Phaseolus vulgaris), and a comparison was always made with a plant watered with spring water. 'Until now,' the author observes, 'plants have been supposed to be distinguished from animals by the absence of organs corresponding to the nerves of the latter class; but the results of my experiments tend to prove that they are capable of being affected by such poisons, in a manner analogous to that in which animals are affected by them.' His experiments may be divided into those in which metallic poisons were employed, and those in which vegetable poisons were the agents. *Metallic poisons.*—A vessel, containing two or three bean plants, each with five or six leaves, was watered with two ounces of water, containing twelve grains of oxide of arsenic in solution. At the end of from twenty-four to thirty-six hours, the plants had faded, the leaves drooped, and had even begun to turn yellow. Attempts were afterwards made to recover the plants, but without success. A branch of a rose tree was placed in a solution of arsenic, and in twenty-four hours, ten grains of water, and 0·12 of a grain of arsenic had been absorbed. The branch exhibited all the symptoms of unnatural decay. In six weeks a lilac tree was killed, in consequence of fifteen or twenty grains of moistened oxide of arsenic having been introduced into a slit in one of the branches. Mercury, under the form of corrosive sublimate, was found to produce effects similar to those of arsenic. But no effect was produced upon a cherry tree, by boring a hole in its stem, and introducing a few globules of liquid mercury. Tin, copper, lead, muriate of barytes, a solution of sulphuric acid, and a solution of potash were, found to be all equally destructive of vegetable life. But it was ascertained, by means of sulphate of magnesia, that those mineral substances which are innocuous to animals, are harmless to vegetables also. *Vegetable poisons.* In the experiments with vegetable poisons, the bean plants were carefully taken from the earth, and their roots were immersed in the solutions used. It had been previously ascertained, that a plant so transplanted and placed in water, under ordinary circumstances, would remain in excellent health for six or eight days, and continue to vegetate as if in earth. A plant was put into a solution of nux vomica, at nine in the morning. At ten o'clock the plant seemed unhealthy, at one the petioles were all bent in the middle, and in the evening the plant was dead. Ten grains of an extract of Cocculus menispermum, dissolved in two ounces of water, destroyed a bean plant in twenty-four hours. Prussic acid produced death in eighteen hours; laurel water in six or seven hours; a solution of Belladonna in four days; alcohol in twelve hours. From the whole of this experiment, M. Marcet concludes, 1st. That metallic poisons act upon vegetables nearly as they do upon animals. They appear to be absorbed and carried into different parts of the plant, altering and destroying the vessels by their corrosive powers. 2nd. That vegetable poisons, especially those which have been proved to destroy animals by their action upon their nervous system, also cause the death of plants. Whence he infers that there exists in the latter a system of organs which is affected by poisons nearly as the nervous system of animals.

19. From these experiments it is impossible not to perceive that the fibrous tissue of plants and of animals, as well as their absorbent vessels, are acted upon in the same way by the application of injurious matter, whence it must be concluded, that a strict similarity exists between the two kingdoms in that particular.

20. In sensibility, as distinguished from irritability, or in the possession of a nervous system, there is now scarcely room for doubting that plants agree with animals. The discoveries of Dutrochet show that in the system of vegetables a matter exists which is altogther analogous to the nerves of animals. The latter are composed of an agglomeration of an infinite number of minute globular particles, which are concrescible by the action of acids, and resoluble by the application of alkalies. In the sensitive plant, Dutrochet has ascertained that sensibility depends upon the presence of a vast number of

particles, which are affected by chemical agents in the same way as the nerves of animals. They line the cellular tissue, and are plentifully distributed over the tubular and spiral vessels, or tracheæ.

21. Neither can the power of perception be denied to exist in some plants, in as distinct a state as in many animals. We see that the former move, that they seize little insects, that they retreat from the approach of danger, and that they appear to possess a faculty of selecting that nourishment which is best adapted to the peculiarities of their structure. Can any one attribute the power of sense to zoöphytes, to corallines, and deny its existence in the Dionæa, or the sensitive plant? is it possible to ascribe it to the Infusoria, and to refuse it to Oscillatorias? surely, no argument can be employed in justification of such an opinion, except such as may be deduced from analogy. And let us see to what such an argument may be imagined to amount.

22. On one hand, considering that zoöphytes perform motions precisely similar to those which are peculiar to animals visibly provided with nerves and muscles, we should conclude that the motions of zoöphytes have a similar origin; and on the other hand, bearing in mind that the small number of plants which perform what appear to be voluntary motions are, in all apparent respects, organised in just the same way as other plants which have no such motion, we are equally justified in inferring that those plants in which no motion is observable have the same power of contraction as the others, but in an insensible degree.

23. In their different modes of generation, animals and plants are remarkably similar. Envelopes more or less hard and numerous; an embryo concealed within these envelopes; a small quantity of nutrition ready prepared for the early use of the young being; these are common both to the seed and the egg. A double foramen exists in the ova of many of the lower animals, as in frogs; it is equally present in the seed, or ovula, of nearly all plants. If almost all animals have eggs, so have almost all plants seeds.

24. Many vegetables have no seed; many animals have no eggs. Both are multiplied by the extension and natural separation of their peculiar substance. On the surface of many polypes are found little tubercles, which generally enlarge, become detached, and form, at a greater or shorter distance from the parent stock, other polypes, which soon become capable of increasing by the same means. Confervæ are known, in several cases, to increase in precisely the same way. Of what degree of precision then is the most perfect of the following definitions of a plant; proposed by observers who are placed at the head of their science? Stones grow; vegetables grow and live; animals grow, live, and have perception. *Linnæus.* A plant is a compound organic body, deriving nourishment from the soil in which it grows. *Link.*

II. History of the Science.

25. The physical sciences are generally supposed to depend almost entirely upon the powers of human observation for their perfection and final development; and it was formerly admitted as an incontrovertible axiom, that philosophical induction, or metaphysical classification, had little or no effect upon the actual amount of ascertained facts; or, which is the same thing, upon the elements of science. It has been a common belief, that the classification of natural objects, has no other end than that of forming a sort of index to the science of natural history, and that systems bear the same relation to sciences as alphabets to languages. With regard to botany, the description of a plant, with a detail of its qualities in medicine or art, actual or supposed, was the utmost which was formerly attempted by the most celebrated writers; and it certainly was never by such persons for a moment supposed, that an acquaintance with the mutual relations and affinities of the vegetable kingdom, would in any degree influence the discovery of new objects. But the experience of modern times has shown, that directly the reverse of this opinion is consonant with facts, and that so long as the mind remained occupied in no other manner than in the acquisition of new plants, without knowing in what way to appreciate their respective peculiarities, discoveries continued to be made slowly, and to be of little value when made. As soon, however, as botanists arrived at the art of arranging, upon philosophical principles, the materials which they possessed, their attention was strongly directed towards supporting their respective systems by the addition of new objects and new facts. Their minds were excited by the hope of undiscovered forms enabling them to fill up chasms, which, they could not fail to perceive, existed in the most perfect methods known to them; and the strenuous investigations instituted on this account, naturally brought them acquainted with an abundance of subjects, the existence of which the imperfection of their previous knowledge could not have led them to suspect. Thus we perceive, that during the space of more than 5500 years, from the creation of the world to the time of Cæsalpinus, a period during the greater part of which botany was an humble art, necessarily, from its intimate connexion with the wants of mankind, the study of physicians, the whole number of recorded plants of all descriptions scarcely equalled the quantity now produced, under the auspices of science, by the investigations of a twelvemonth.

26. In the east, at first the only seat of erudition, the greatest care was taken to acquire a knowledge of the beneficial or noxious qualities of different natural productions. The Chaldeans communicated their knowledge to the Egyptians, and these to the Greeks. In Greece, where, indeed, real science first originated, Æsculapius attempted, by means derived from the vegetable kingdom, to cure some diseases. Medicine soon became intimately connected with religion. In the temples dedicated to the worship of the gods, the prescriptions of Æsculapius were publicly hung up, and the priest alone undertook the examination and the search of officinal plants, and the treatment of different diseases. They were, as followers of Æsculapius, called Æsclepiades.

27. The father of medicine, Hippocrates, added to the observations of Æsculapius a great many of his own, and first published several works on medicine. In his writings, the diseased and healthy state of man are fully treated of, and in speaking of the methods of cure, he has mentioned about 234 plants. But these are only names. Hippocrates was born about 459 years before Christ, at the Island of Cos. He lived to a very old age, though on that point authors differ, some saying he lived to be 89 years old, some 90, others 104, and a few indeed 109. The plants he mentions can scarcely be guessed at; for though great natural philosophers and linguists have attempted, long ago, to fix them properly, notwithstanding all their endeavours they still remain very doubtful.

28. Among the ancients, Thales, the Milesian, holds the earliest station as a philosopher. He perceived in the whole range of natural bodies nothing but mind, dæmons, and a divine nature. As the ocean was the parent of his gods and goddesses, so was water the primitive origin of all created things. Aristotle conceives that the humid state of all nutriments, and the aqueous nature of all seeds in the beginning, gives a plausibility to this hypothesis. *Metaph.* i. 3.

29. Pliny testifies to the deep knowledge of Orpheus in the properties of plants, but Pythagoras the Samian is the first who is known to have written any treatise upon botany. This philosopher procured his information from the Egyptian Magi. He first taught the miraculous uses of the Scillà maritima, in prolonging life; the bulb pickled in vinegar was affirmed to gift the vinegar with the power of extending the period of human existence to the hundred and seventeenth year. He declared the virtues of Anise against the bite of scorpions, the power of Brassica, and of Sinapis.

30. Empedocles, of Agrigentum, one of the disciples of Pythagoras, wrote a poem on the agency of the four elements. He conceived that plants were formed from the united agency of fire and earth, that they grew upwards through the influence of the former element, and downwards by the action of the latter, that air was diffused through their branches, earth through their roots.

31. This opinion may, however, be rather considered as part of the doctrines of the exoteric philosophers, who adopted the notions of the poets about the origin of things, and supported them by the subtlety of materialism. That plants are animated beings they held to be proved by the motions of which they are susceptible, and by the elasticity of their branches, which, when bent, resume their natural position, as soon as the external power is removed. They believed that plants were all subject to a metamorphosis into animals, or the contrary; and that no man could be sure that he had not, at some period of his existence, been a plant, a bird, or a fish. For this reason the laurel was held to be the noblest of trees, as being that into which man is translated after death. They admitted that the sexes were united in plants: but they supposed that they became separated upon the change into animals. They were moreover believers in the presence of a soul in plants; of a peculiar nature, indeed, but endued with intelligence and γνωσις, appetites and sensations. Even reason was ascribed to them by Sextus Empiricus. He declared that they were propagated by eggs, in the way of animals, and that their leaves were analogous to the hairs of animals, and the scales of fishes, that their root performed the functions of head and mouth, because it was through it that nutriment was introduced into the system.

32. Similar opinions were held by Anaxagoras, of Clazomene, who also thought that earth was the mother and the sun the father of vegetation. That their spiritus, or soul, was absorbed from the air by their leaves, and exhaled by the same organs.

33. Democritus the Abderite, who spent his early life in travelling through Persia and Egypt, adopted the notions of the Magi respecting the supernatural powers of herbs. He is said to have composed a work upon their hidden and miraculous virtues.

34. These and a few more are those who are supposed to have existed previously to the time of Aristotle. Among their opinions it is curious to observe how much of truth, even in their abstract speculations, is mixed with the fables of their poets. It is evident that they were acquainted with the sexes of plants, and with the principle that all vegetables proceed from ova. Some light was also possessed upon the functions of leaves.

35. But it was with Aristotle that the real origin of natural science must be said to have arisen. That extraordinary man embraced in his observations the whole circle of nature, from the structure and generation of the Sepia, the Nautilus, and other similar animals, to the elephant and to bipeds. That he paid extensive attention to plants is to be inferred from his own statement, that he had written two entire books upon the subject. He calls these books a Theory of Vegetation, and, in another place, he promises that he will enter at large upon the nature of vegetables. These books are even cited by Diogenes Laërtius, v. 25, Athenæus, xiv. xviii. p. 652, and by the scholiast Nicander, v. 645, p. 42. The books which have come down to our time are, however, believed to be forgeries. They correspond neither with the gravity, the dignity, nor the erudition of Aristotle. But much may be gathered from the genuine writings of this classic, as to the nature of the opinions which he held respecting plants, as forming a particular portion of animated nature; and most especially as to his ideas of their analogies with animals. He appears to have applied himself, with incredible industry, and most remarkable ingenuity, to the discovery of their relative degrees of organisation, and of those functions and phenomena which bore upon his own philosophical system. He was the first to conceive the speculative notion of a continuous chain of organisation, in which the most perfect beings gradually degenerate into an imperfect state. 'Nature,' he declares, 'is continually progressing from inanimate objects to animals, and this through beings which are animated, indeed, but which

are not animals; so small is the difference which exists in nature between proximate beings. As among marine animals many may be found whose dissevered limbs maintain a separate life, so among plants morsels of the epipetron (Sedum acre,) suspended from a nail, will nevertheless retain their vitality for a long period.' In another place, he repeats the same remarks, and adds a comparison between plants and his ostracodermata or shell-fish. He believes that the latter are, in fact, plants, if considered with respect to the gradations of other animals, for most marine animals manifest a power of sensation very obscurely, and others in no degree whatever. In a third place, he pronounces plants to be a sort of terrestrial ostracodermata, and the latter to be marine plants. In the same proportion as water is more prolific of life than land, in the same degree are ostracodermata more vivacious than plants. He conceives that the main difference between plants and animals consists in the absence of excrementitious matter from the former; whence the roots, which absorb only such nutriment, as is already prepared, may be said to make use of the earth and of its heat, as a stomach and intestine. The minute quantity of excrementitious matter which is parted with by plants has an agreeable odor, whilst that of animals is almost always the reverse. He believed with Anaxagoras, that the nature of plants was hot and dry, and that earth was the mother and the sun the father of vegetation. Whence he thought might be explained the greater richness and fragrance of fruits and flowers growing on a hot soil under a burning sun. Aristotle admitted only one end in vegetation, which was the generation of fruits. Whence, the more imperfect were animals, the more similar they became to plants in this respect. All the nutrition and increase of plants appeared to him to tend to this object. He thought that the power of absorbing nutriment, and the mere circumstance of food being necessary to plants, rendered it impossible to deny their sensation, and hence a vital principle. He denied the separation of sexes in plants by which he gained an additional argument as to their affinity with the imperfect animals, in which the union of sexes in the same individual had been observed. The mixture of sexes, which had been assumed by Empedocles, was received as an axiom by Aristotle. Gener. Anim. iii. 10. Aristotle was not, however, free from the errors of his age, or from the love of wonders and miracles. He asserted that the Ruta flourished best when grafted on the fig-tree.

36. This philosopher was succeeded by various writers, whose works are now almost wholly unknown, but who do not seem to have thrown any new light upon the philosophy of botany, but to have confined their observations to the properties of herbs and roots. They are now known only by the quotations of their works in the books of later botanists. Here it will be sufficient to enumerate their names. They are Thrasyas and his disciple, Alexius, whom Theophrastus judges to have been more skilful than his master. Eudemus, Aristophilus, Cleidemus, Menestor, who entertained the remarkable notion that aquatic plants are naturally warmer than terrestrial, because they are not killed by the winter's frost; Hippon, Diogenes, who taught that plants are the consequence of a mixture of earth and putrid water, Leophanes, and Androtion. Besides these, Eumachus, Anacreon, and Micton, are thought to have lived before the time of Theophrastus, but this is uncertain.

37. If Aristotle is to be considered the founder of the philosophy of botany, the adaptation of his opinions to practice is, as far as we now know, to be ascribed to his friend and disciple Theophrastus, born in the year 370 B.C. Such was the fame of this philosopher that, when his master retreated to Chalcis, he succeeded to his school, whither no less than 2000 disciples repaired. In his Historia Plantarum, he described all the plants which were known in his day, either by description or actual observation. The text of that part of his work which has descended to our days is remarkably corrupt, but much light has been thrown on it by the critical acumen of the learned Sprengel. No order is pursued in arranging his descriptions, the same name is often applied to extremely different plants, and his opinions upon abstract matters do not seem to have been different from those of Aristotle. He was a believer in the transmutation of species, and even genera, and treats at large upon the subject. His nomenclature of the parts of plants is the first upon record in which an attempt was made to attach precise ideas to particular terms; and in this he succeeded remarkably well. The physiology, or 'the physick' of trees was understood by him in a manner which necessarily gives us a high opinion of the state of philosophical knowledge at his day. He distinguished between the structure of the trunks of palms and other trees, or, in modern terms, between monocotyledones and dicotyledones. He discovered that nutrition was conveyed to plants through their leaves, but he attributed this power to both surfaces alike. The sexes of plants were not unknown to him, but his ideas on the subject were incorrect. In short, that part of his history which appertains to vegetable physiology offers a mass of observation and reasoning, which is well worth consideration even at the present day

38. Little is known of the Alexandrian school, which succeded Theophrastus. Diphilus, who lived in the time of Lysimachus, first discovered the use of asparagus as a pot herb; and described for the first time the Persica coccumela or peaches. A manuscript of the works of Cratævas is preserved in the library at Venice, but it contains no information of importance.

39. When the Romans became masters of Greece, they adopted the writings and opinions of the latter country so completely, that there is in natural history scarcely any additional information in the writings of all their naturalists. Some inconsiderable additions were made to the list of plants, but very little change took place in the opinions held of the nature and properties of beings.

40. To pass by the agricultural writers, Cato, Varro, Diophanes, Virgil, Columella, and others, who are by some moderns ranked in the list of Roman botanists, the first author whose writings are of present value is Pedacius Dioscorides, who flourished in the time of Nero. Attached

to the Roman army, he traversed Greece, Italy, and Asia Minor, in which countries he collected many new plants. But, in his history, he described by far the greater part of those he mentions, upon the authority of others. He was acquainted with no method of arranging his plants, which were frequently classed from some similarity in their names, rather than in their nature. His descriptions are so imperfect, that the name only is given of many plants. His catalogue, however, of the plants of Greece and Italy, was by far the most complete which had been compiled in his day.

41. He was followed by Caius Plinius Secundus, who was born in the twenty-third year of our era, under Tiberius Cæsar. The fame of this remarkable man has reached to all the corners of the civilised earth, and he is on all hands pronounced to have been the father of natural history. He was a person of great learning, considerable acuteness, and unwearied industry. His reading was more extensive than that of any of his predecessors or contemporaries, and his writings are reported to have been scarcely less voluminous. Judging from the books upon natural history, which have come down to our time, his high reputation may be stated to have been very little deserved, except on the score of industry. They chiefly consist of almost literal compilations from the works of his predecessors, especially of Dioscorides. The arrangement of the matter is uncertain and empirical; the descriptions of his subjects meagre, vague, and unsatisfactory; the qualities assigned to them fanciful, childish, and unphilosophical. The advantages he possessed of having visited the most remote of the Roman provinces, in the capacity of a general officer, were turned to small account by him in discovering new objects of natural history. In a word he must be pronounced to have been a mere compiler without observation, experience, or judgment.

42. Galen succeeded Pliny, and turned the great powers of his mind to the subject of botany, but in a medical view only. So that a few new plants were all which natural science derived from his labors.

43. Thus much has been said upon the state of botanical knowledge up to the time of Galen, in order to make it appear what was the actual amount of discoveries during the first epoch of natural science. It is worthy of remark, that the period was fraught with fanciful conjectures, and often ingenious hypotheses; but that philosophy was unaided by experience, and that metaphysical speculations usurped the place of accurate observations.

44. In the early ages of the world, the science therefore, which is now called botany, consisted of a collection of names, and exceedingly imperfect descriptions of plants; either entirely unarranged, or combined according to their supposed qualities in medicine, or in human economy.

45. The race of botanists who succeeded the classics, were physicians or mere simplers, who cared for no classification beyond that which enabled them to arrive at an imaginary knowledge of the powers and effects of the few herbs which were imported for pharmacy, or which grew in their vicinity. Even after the revival of learning in Europe, the same ideas were entertained, and a proportional progress was made in the acquisition of knowledge. The second race of botanists, or those who existed after the dark ages of Europe had passed away, were the commentators upon the writings of the first race; men of some learning, indeed, but in the deepest ignorance of the subject they undertook to illustrate; monks, whose practical knowledge extended not beyond the walls of their monastery, and who depended for all the information they found necessary to their purposes, upon the assistance they could derive from the few copies of the Arabian physicians, which their own or their monastic libraries might chance to possess. Science in the hands of such men, would, it may be easily believed, retrograde rather than make advances towards improvement. So that, up to the time of Vincentius Bellovacensis, who has been called the Pliny of the middle ages, and whose Speculum Quadripartitum was published in 1494, the second volume of which is devoted to the subject of natural history, it may be safely affirmed, that no progress whatever, in modern times, had been made in botany; the whole of this author's materials having been borrowed from Aristotle, Dioscorides, Isidorus Macer, Pliny, Avicenna, Platearius Actor, and Cassius Felix, an obscure writer, whose works are lost. But the practical ignorance of the monks was not the only evil which impeded the advance of physical knowledge. They were in many instances deplorably unlearned in the languages from which they borrowed their opinions. With Arabic, the only source to them of new ideas, they were in most instances imperfectly acquainted: and the degree of knowledge which they possessed, even in the Greek language, was so low, that they were led into the commission of continual errors, in translating the fables of classical writers into the dreams of themselves. Another and a more serious consequence than the decline of science, was the result of this deplorable state of botanical learning, which, as a modern writer has justly observed, was so desperate that it is not more surprising that it should have arrived at it, than that it should ever have been extricated from it. By a frequent misinterpretation of the Arabic writers, it not unfrequently came to pass, that properties were ascribed to plants which were directly the reverse of those which the original authors attributed to them; a curious instance of which occurred with respect to the cinnamon. This was for a long time considered a deadly poison, in consequence of Nicolaus Myrepsicus, a Greek physician, who flourished in the thirteenth century, having translated dar-sini the name given to the cinnamon by the Arabians, by the word *ἀρσένικον*.

46. The time, however, arrived, when some truly learned men undertook the exposition, not only of the blunders of their contemporaries, but of the ignorance or corrupt text of those original authors in whom a blind confidence had for so many ages been reposed. The bold attack of Hermolaus Barbarus upon Pliny, and of Nicolaus Leonicenus upon Serapio, and the Arabian

writers, the one published at the end of the fifteenth century, the latter at the commencement of the sixteenth, put an end to the delusion under which the world had labored for so long a time. These men fearlessly tore the mask from before the face of the impostors of their day, and boldly succeeded in convincing the world that the ignorance of antiquity had been mistaken for the experience of ages; and a new impulse was given to the pursuits of naturalists, not only by these writers, but also by the declaration of Collenuti, an earnest defender, indeed, of the originality of Pliny, that 'non satis esse ad herbariam perdiscendam tradendamque, herbarios scriptores legere, plantarum videre picturas, Græca vocabula inspicere, magistri unius verbis addictum esse, sed rusticos montanosque homines interrogare oportere.'

47. To particularise all the obscure writers, who existed up to this period, would be an unprofitable waste of space and attention. All kinds of learning had been brought to so low a state of degradation, by the insane and stupid madness of the worthless men who sanctified their acts under the cloak of religion, and who, in their pretended zeal against paganism, destroyed all the fountains of knowledge, that there was scarcely an author upon botanical matters, during this long period, who deserves to be handed down to posterity. Between the first and the early part of the sixteenth century, natural history may be considered a blank, during which that description of learning was buried in a deep trance. In the strong language of one of the earliest revivers of botanical science: 'Those writers who did occupy themselves with the subject, especially Matthæus Sylvaticus, and Simon Januensis, deserve the execration of all posterity, for their worthless compilations and treacherous translations of the ancients.'

48. The second period presents us with more promising views. All science began to revive, and monasteries were no longer the exclusive seat of human knowledge. Brunfelsius, Gesner, Fuchsius, Dodonaeus, the ever memorable Clusius, and the great Bauhin, opened the path to the present state of botanical science.

49. Otto Brunfelsius, son of a cooper, was born at Maynz, at the end of the fifteenth century. He was first a Carthusian friar, and became, soon after, cantor (precentor) in Strasburg. In his work he has given the first figures of plants, and he was also the first botanist in Germany. The drawings are not very good, and do not in the least correspond with his own descriptions.

50. Hieronymus Bock, was born at Heidesbach, in Deux Ponts, 1498. He died in the fifty-sixth year of his age, the 21st of June, 1554. He changed his name, according to the fashion of his age, to the Greek name Tragus. In three books of his work he treated pretty accurately of those plants which grow in Germany, and represented the described plants in 567 figures, which are not bad. It is an objection made to him, that he neglected the virtues of the plants, though he knew them perfectly well, and that he used the writings of the ancients too little. He wrote a history of plants, of which many editions have appeared in German, French, and Latin. He likewise wrote notes to Dioscorides, Galen, and Hippocrates, on which account he entered into a long dispute with the famous physician and philologist, John Heynbut or Hagenbut, who likewise called himself Cornarus. Cornarus published a treatise against him, entitled Vulpecula Excoriata. The botanist, Fuchsius, answered in another, with the title, Cornarus Furiens; after which Cornarus finished the dispute with the publication of a work, which he termed Mitra, S. Brabyla pro Vulpecula Excoriata Asservanda.

51. Peter Andreas Matthiolus, a physician at Sienna, was born in the year 1500, and died at Trent, in 1577, of the plague. He had carefully studied the works of the ancients, especially of Dioscorides. His Kraeuterbuch (work on plants) was written originally in Italian, but we have French and German translations of it.

52. Matthias de Lobel, physician to king James I. of Great Britain, was born at Brussels, in Flanders, in 1538, and died in London, 1616. Together with Peter Pona, a physician in Provence, he wrote the Adversaria, part of his greater work. He says that this physician sent him many rare plants. Some assure us that he has in his works given many ideal figures of plants; and he has described several as growing wild in Britain, which after him nobody could ever find.

53. Charles Clusius, or Charles de l'Ecluse, was born at Arras, in the Netherlands, 1526. His parents wished him to become a lawyer, and he went with this design to Louvain. But he presently changed his mind, and, from his great love of botany, soon undertook the most tedious and troublesome journeys through Spain, Portugal, France, Great Britain, the Netherlands, Germany, and Hungary. In his twenty-fourth year he became dropsical, of which, however, he was cured by the use of succory, recommended to him by the famous physician, Rondeletius. In his thirty-ninth year, in Spain, he fractured his right arm close above the elbow, falling with his horse, and soon after he broke his right thigh. In his fifty-fifth year, at Vienna, he sprained his left foot, and eight years afterwards dislocated his hip. This last dislocation was neglected by his physician, and he had the misfortune to walk for the remainder of his life on crutches. The great pain and difficulty he had thus to suffer when walking, prevented him from taking the necessary exercise, in consequence of which he was affected with hernia, obstructions in his abdomen, and calculous complaints. Thus miserable and unhealthy, tired of the court of the emperor, where he had resided for fourteen years, and finding, besides, the superintendence over the gardens there too great a burden, he accepted, in the year 1593, an invitation as professor at Leyden, where he died, April 6th 1609. Clusius was the greatest genius of his age, and prosecuted the study of botany with an enthusiastic zeal, and a perseverance which was not equalled by any preceding philosophers, or by that of any of his followers. His works exhibit a great botanist, and they will always remain valuable and indispensably necessary. The figures annexed to

them are neat, the drawings correct, and his descriptions masterly. It was a pity that a man of such great merit should have suffered so much, and even become the first martyr to botany.

54. Andreas Cæsalpinus came from Arezzo, in Tuscany. He was called to Rome, as physician to Clement VIII., where he died, the 25th of June, 1602. Before him plants had been described without the least order, and nobody thought, by attending to the similarity of different parts, to render the study of botany more easy. His system will render him ever memorable. The writings of this botanist are so rare, that scarcely more than their titles are now known; but they are among the most valuable in the world.

55. Jacob Dalechamp, born at Caen, in Normandy, in the year 1513, spent most part of his life at Lyons, and died there in 1588, or according to some, 1597. He was the first who intended to write a general history of all known plants; but, by other occupations, he was prevented from continuing it. An accomplished physician at Lyons, of the name of John Molinæus, completed it, at the desire of the bookseller Rovilli.

56. Joachim Camerarius (son of the celebrated commentator), was born at Nuremberg, the sixth of November, 1534, and died October 11th 1598. He lived with Melancthon, at Wittemberg, when a boy, and afterwards studied medicine at Leipzig. Camerarius wrote several treatises on economical botany, and on the plants of the ancients. His principal work contains forty-seven figures, from Gesner's collection. For he purchased Gesner's whole collection of cuts, which amounted to about 2500. He made great use of them in his edition of Matthiolus, and in another work, still of great value.

57. Jacob Theodore Tabernæmontanus, a pupil of Tragus, took his name from his native place, Bergzabern, a small village in Deux Ponts. He was first an apothecary at Kronweissenburg, he went afterwards to France, returned as doctor of medicine, and at last died as physician to the elector palatine, at Heidelburg, 1590. He was generally esteemed for his great skill. His work was not finished by himself. The second and third volumes were written by another, and are inferior to the first.

58. Leonard Rauwolff, a German, undertook a troublesome journey throughout the Levant. He travelled in the years 1573—1575 through Syria, Arabia, Mesopotamia, Babylon, Assyria, and Armenia. After his return he settled as physician at Augsburg. On account of his religious profession he was obliged to leave his native place, and died, 1596, as physician to the emperor's army. He has published a very complete account of his journey.

59. Prosper Alpinus, from Marostica near Venice, went, on account of his love for botany, to Egypt. After his return, he practised as physician in Venice, and then in Genoa; he went at last as professor to Padua, where he died, in 1617. He was universally regarded as a very able man. Botany is indebted to him for a few curious little works.

60. John Bauhin, was born at Lyons, in 1541. He was a pupil of Fuchsius: and left his native country, and remained for some time in Yverdon, a town in the canton of Bern. He then went to Muempelgard, where he died, as physician to the duke of Wirtemberg, in 1613. He travelled through the greatest part of Switzerland and Italy. When a youth he commenced his great work, which he only finished fifty-two years after. In this extraordinary performance, a history, extremely well arranged for the time, and admirably compiled, was given of all the plants which had up to that time been published. It was illustrated by a vast multitude of wood blocks, and is the first work of the nature of what are now called Species plantarum. The works of Bauhin will always stand as landmarks in science for the benefit of all succeeding ages. His younger brother, Gaspard Bauhin, who died at Bâsle, in 1624, trod closely in his footsteps, and deservedly ranks high among the botanists of that age.

61. From this memorable period of improvement, in which the Herculean labors of John Bauhin and his brother, as well as the arrangement of Cæsalpinus, had not only advanced the study of vegetables to an unprecedented height, but seemed also to have ensured its continued and unremitted progress; botany, as represented by botanical historians, appears notwithstanding to have languished for a period of nearly half a century; which might perhaps have been owing to the impossibility of outdoing the Bauhins in their own line of investigation, and upon their own principles. But if the progress of the study of vegetables was thus suspended, inasmuch as relates to the collecting, describing, and figuring of plants, there is at least one view of the subject in which it was most essentially advanced; and that is in the revival, if one may not absolutely say original introduction, of phytological investigation, which had been attempted by Theophrastus, and consigned to the most culpable neglect by succeeding botanists, for a period of nearly 2000 years.

62. The revival of this study was probably owing to the new impulse and new direction communicated to the spirit of philosophical enquiry by that great and illustrious luminary of science, Francis Bacon, Lord Verulam, who, having explored and developed the true foundations of human knowledge with a sagacity and penetration unparalleled in the history of mankind, and having dared to disengage himself from the fetters of academical authority, denounced as vain and idle the visionary speculations of the schools, and boldly pointed out the necessity of a complete and thorough revolution in all pre-established methods of study; recommending the more tedious, but yet more successful, method of analytical and inductive investigation, and proclaiming truth to be but the image of nature. But to whatever cause it may be attributed, the fact is, that two different sets of phytological experiments modelled upon the principles and methods pointed out by Bacon, and with a view to elucidate the phenomena of vegetation, were instituted about nearly the same time, by two celebrated anatomists, and accurate observers of nature, residing in different countries, and having no communication with one another. These

naturalists were Grew and Malpighi; the latter an Italian, the former an English physician. For as Gesner and Cæsalpinus had been led, as it were, instinctively to the study of methodical arrangement without any mutual intercourse, so were Grew and Malpighi to the pursuit of phytological enquiry; a circumstance likely to happen, at a time when the spirit of true philosophy had begun to diffuse itself among men of speculative hábits, of whom many, no doubt, would be led to view the same subject in the same light.

63. The result of the investigation of these illustrious phytologists was first communicated to the public towards the end of the seventeenth century; and it must be confessed that the success of their labors made amends, in a great measure, for the long neglect of preceding naturalists; for though they had no track to direct them in this obscure and intricate investigation, yet by joining patience to penetration, and experience to philosophy, and by adopting the only sure means of detecting the secrets of nature, the experimental mode of enquiry; exploring most scrupulously the internal and recondite structure of plants, and watching with unwearied application the functions of the different organs, they succeeded in removing much of that veil which had enveloped the phenomena of vegetation; and in opening up to the observation of man a new view of the works of God.

64. But the principles of the philosophy of Bacon, which were thus so successfully applied to phytology, were extended also to botany; particularly on the subject of arrangement, and ground of generic distinction—the necessity of which was now more than ever indispensable, for the purpose of reducing to order the immense mass of particular specimens, collected and described by the increasing multitude of adventurers in the field of botanical discovery. Accordingly, in pursuit of this important object, the talents and industry of the learned were now also more than ever exerted, and a variety of systems introduced, adopted, and abandoned, in their turns.

65. Of these the principal were the methods of Morison, Ray, Tournefort, Rivinus, Boerhaave, Herman, and Magnol, which appeared about the end of the seventeenth or the beginning of the eighteenth century; and which, whatever might have been their defects, had at least the merit of exhibiting botany under a new and systematic form. But the most celebrated as well as the most beautiful of them all was that of Tournefort, which was adopted in France with a kind of epidemic enthusiasm characteristic of the nation, and which has been admired by botanists of all countries. It had, indeed, much merit, at least as exhibiting the first model of generic discrimination, founded on principles truly philosophical. But it had also its defects; for, extremely beautiful in speculation, it was yet clogged with insurmountable difficulties in the practice.

66. No method of arrangement, therefore, had yet been discovered sufficiently suited to the exigency of the case; and a method founded on principles more easily reduced to practice, was still the grand desideratum of botany.

67. In this peculiar crisis of botanical perplexity, when specimens were every day multiplying in the hands of collectors, when herbariums were devoid of arrangement, and the science was in danger of relapsing again into an absolute chaos; a great and elevated genius arose, destined to restore order, who surveying the immense mass of materials with a sagacity and penetration unparalleled in botanical research, and seizing, as if by intuition, the grand traits of character calculated to form the groundwork of a philosophical division, detected the clue by which he was to extricate himself from the intricacies of the labyrinth, and rear the superstructure of a legitimate method. This great and illustrious naturalist was the celebrated Linnæus, who deducing his rules of method from the most incontrovertible of all principles, and establishing the laws of generic and specific distinction, and even rules of legitimate definition, introduced into the study of botany a simplicity of system, a perspicuity of arrangement, and a precision of language, which have elevated it to the high rank it now holds in the scale of human knowledge, as well as allured to the study of the science men of the most distinguished abilities, and excited that ardor for botanical investigation which characterises the present age.

68. Now let us trace the progress by which this stock of knowledge was acquired. In the Holy Bible it has been ascertained, from the investigations of Sprengel, that there are seventy-one plants noticed by name; which, generally, are such only as were applicable to the purposes of man; and, viewed in this light, the number, as compared with those known to the early heathen writers, is far from inconsiderable. The Homeric Flora amounts to less than thirty species; that of Hippocrates, in the year of the world 3630, to 274 species; and of Theophrastus, who is supposed to have flourished about the same time, to something like 500 species. Dioscorides, who, it is most probable, lived in the time of Cleopatra, more than 300 years later than Theophrastus, notices 600 plants; and finally, Pliny, in the seventy-fourth year of the Christian era, compiled, from an examination of more than 2000 volumes of Greek and Roman writers, an account of nearly 1000 species, the result of the investigations of more than forty centuries. In the succeeding 1400 years, we have already seen that the progress of botany was so slow, that if an increase of 500 species is allowed to have taken place during that long period, it is as many as can possibly be made out to have been discovered. But the two next centuries, when the knowledge of plants was assuming a scientific form, produced, after making every allowance for repetitions and spurious species, upwards of 4500 new plants; a number more than three times greater than had been ascertained in all the ages of the world before.

69. But if we find the opinion expressed at the commencement of this chapter confirmed by the experience of the ages anterior to Tournefort, how much more strongly is it supported by

the evidence of modern times. In the first edition of the Species Plantarum, published fifty-three years later than the first edition of Tournefort's Institutes, the number of species amounts to 7300; but so extraordinary was the advance of botany under the auspices of philosophical classification and of Linnæus, that in a few years more it was found that 1500 plants could be added to the list. Pulteney, indeed, makes only 7800 in all; but in this he must be mistaken.

70. The number, however, of species described by Linnæus, even in his latest work, is by no means to be taken as the standard by which the actual state of knowledge at his time is to be measured. It is well known, that his notions respecting species were peculiar to himself, and it must also be supposed that the difficulty of adapting the half described species of his predecessors to his system, operated with him in some degree in inducing him to neglect their labors, in cases in which his own knowledge did not chance to be such as confirmed their opinions and descriptions. For this reason he often omitted the discoveries of Tournefort, whom he also viewed, and with justice, as his most powerful rival. But the most remarkable instance of his oversight is to be found in the lower orders of vegetables; an obvious example of which is afforded by fungi, of which he notices in the most perfect of his works only ninety-three species, at a time when Micheli had described nearly 800 species of Agaricus, or at least of pileate fungi, peculiar to Italy alone. Hence it follows, that a just criterion of the number of plants known in the days of Linnæus can by no means be formed from consulting that writer's works alone; if, on the contrary, we take into account his omissions, and deduct from the Institutes of Tournefort one third for garden varieties, which are improperly ranked as species in that work, we shall be justified in fixing the number of species actually described in works of botany at the time of Linnæus's death, in the year 1778, at the following numbers:

	Species.
Described in the second edition of the Species Plantarum, and the Mantissas	8800
Described in the Institutes of Tournefort (not noticed by Linnæus)	1000
Described in Micheli, and other authors upon cryptogamous plants (not noticed by Linnæus)	1000
Described in the works of Hernandez, Piso, Morison, Ray, Bauhin, &c. being either not taken up, or confounded with others by Linnæus	800

making the whole number of plants of all kinds, actually described at that time, amount to 11,600, or, in round numbers, to 12,000 species.

71. Notwithstanding the undoubted excellence of the principles and system of Linnæus, it is not to be denied that, had he lived at a less corrupt period, or had he not possessed the singular power of precise language, at a time when he was surrounded by confusion and vague descriptions, his botanical system would have been as unsuccessful as those of his predecessors had been, in establishing itself in the good opinion of the public. The errors of Linnæus have been so glozed over in this country, that it is quite necessary, in a work intended for public benefit, to open the eyes of the public to the nature of his faults, which may be considered under two heads; the errors of his principles and the faults of his system.

72. Nothing could be more improper and injudicious than the arbitrary manner in which he rejected or altered, when unnecessary, the names given by individuals who preceded him; a practice by which the difficulty of bearing in mind the identity of Linnæan plants with those of antecedent authors has been increased to a most inconvenient degree. He was also in the practice of applying the names used by classical writers to modern plants, without any consideration, and often to such as were wholly dissimilar from those of the classics. His rules of nomenclature, as promulgated by himself, however excellent they may be in some parts, are to the last degree gratuitous, and inconvenient in others. He likewise had the glaring fault of not attaching precise ideas to the names of the organs of plants, but under a single name confounded entirely dissimilar parts; as, for example, in the case of his nectarium, which means almost any and all parts of the flower; this circumstance is very remarkable in a man who certainly possessed a very logical mind. His definitions, usually not accompanied by descriptions, are so imperfect and vague, that it would have been impossible to have determined his plants without the aid of his herbarium; a fault which ought to be considered as most grave; and yet his admirers bepraise him for these very definitions. His patience in overcoming the difficulties of condensing the information of his predecessors, and the novel and elegant manner in which he effected this, are however so striking, that one might almost allow that he merited his high fame upon these grounds alone. Nor would it have been requisite to point out faults, such as have been here noticed, had not the indiscriminate admiration of his friends attempted to make it appear that this certainly great man was something superhuman in all his works, while they are as much open to criticism as those of other authors.

73. The famous system of arrangement which was founded by Linnæus, under the name of the sexual system, and which for more than half a century was exclusively employed by a large proportion of the most learned botanists, and which is even now made use of by some of the more venerable existing writers, may be said to have owed its celebrity more to its being the groundwork of the important labors of its inventor, than for any extraordinary inherent merits. A great recommendation with the world has also been its apparent facility and simplicity. The principles upon which this system was founded will be explained hereafter; its application and merits are all that demand attention in this place. As it is entirely and essentially artificial, it must be considered in that point of view only; for which reason all the inventions of modern botanists, which tend chiefly to render it less artificial, will be passed by, as well as be-

cause the innovations of his successors are not attributable to Linnæus.

74. It is obvious that the only merits which an artificial system of arrangement can possess, must be extreme facility and precision of application; and that it will be found defective in exactly the degree in which these qualities are absent. Now, notwithstanding the simplicity of the organs upon which the Linnæan arrangement depends, it is notorious, that it is continually necessary to leave them out of consideration in determining the locality of plants. The species, for example, of a genus vary or differ in the number of their stamens; that genus therefore ought to be found in as many different classes as there is variation or difference of this kind; the species differ or vary in the number of their styles; such a genus would be referrible to as many different orders as there are variations of that nature. These differences exist, not only among species of the same genus, but even in flowers of the same individual; whence cases might be found of particular plants, which belong at the same time to several classes and orders of the system. Can any thing be more objectionable to its use than this fact? and instances of such difficulties are neither few nor uncommon. Another objection to the sexual system is, that no information is gained by its use, and that after employing it for the whole of a life, not a single idea is acquired beyond the half dozen with which it was necessary to set out; the consequence of which has been a misconception of the nature and analogies of the organs of plants, and a general ignorance of the affinities by which individuals are related, a thorough knowledge of which is absolutely indispensable to any systematic writer. That this is the fact may be sufficiently shown, by an appeal to the writings of the very best of the exclusively Linnæan botanists. These points are abundantly sufficient to show the inferiority of Linnæus's celebrated system to the praises of his admirers, and to explain the cause of its almost universal disuse at the present day. As an artificial system, it is unquestionably inferior for ready use, and precision, to the artificial system of the French school. Any ingenious botanist, indeed, would contrive a better, if it were either necessary or useful.

75. The natural method, as it is called, has now, however, so entirely superseded the sexual system, and has become so much more facile than it formerly was, that the utility of any artificial system whatever may now be doubted. This celebrated system is generally said to have taken its rise in France, with Bernard de Jussieu, who in the year 1758 arranged the plants in the Royal Garden of Trianon upon a plan which may be considered the basis of the system in its present state. It is not here, however, an object to enter upon the history of the subject, nor to point out the improvements the method has successively received at the hands of Antoine Laurent de Jussieu, Ventenat, Brown, Mirbel, Richard, and De Candolle. It will be preferable to give a rapid glance at its actual state, principles, and objects.

76. The great principles upon which the natural system depends, are, that plants ought to be considered with reference to all their organs, forms, and peculiarities, and not with reference to an arbitrary selection of any one of these; that a bond of union exists in all nature, by which individuals approximate to individuals by insensible gradations; and that the true mode of arriving at a knowledge of the real nature and station of a given object is, by considering it with reference to the points in which it most nearly resembles other objects, which points are called affinities. By this mode of looking at the science, while it becomes necessary to acquire a knowledge of a considerable number of individuals, in order to understand the nature of any single individual, it also follows that the acquisition of this knowledge facilitates in an obvious manner the subsequent investigation of any new subject. For example, a student who is entirely unacquainted with the science, takes up, for the first time in his life, a grass; he examines it, and discovers that it possesses the characters of the extensive natural assemblage called gramineæ, or grasses, and that it belongs to the section of that assemblage called the genus poa. From that time forward he will, from the investigation he must of necessity have instituted, possess an accurate notion of the properties and peculiarities of gramineæ, and, whenever he again meets with a grass, he will know that it is one, and where in the system at once to refer for information respecting it. The same is consequent upon his studies to the end of his career; each new discovery necessarily increasing his knowledge in various directions, and facilitating the making of discoveries to come.

77. The modes of arrangement, and of analysis, of the natural method are these.

78. The vegetable kingdom is first divided into three portions, according to the structure of the embryo, and of vegetation, viz. 1. Acotyledones, which have no cotyledons, as other plants, but whose seeds or sporules germinate from any indifferent point of their surface, and whose vegetation is constructed entirely of cellular tissue, without the intermixture of tubular or spiral vessels. 2. Monocotyledones, whose embryo has one cotyledon, rarely none, and which in that case germinates from a determinate point, and whose vegetation is formed by increase taking place at their centre, not at their circumference. 3. Dicotyledones, which are formed with two cotyledones, and whose vegetation is produced by the gradual superposition of internal layers beneath the bark. This order of arrangement of the three primary groups was used by Jussieu; it is now more frequently inverted, the Acotyledones terminating instead of beginning the series.

79. Dicotyledones constitute the most extensive part of the vegetable kingdom, and are considered to be in a more perfect state of development than the two others. They are subdivided, 1. According to the number or absence of their petals, into polypetalous, monopetalous, and apetalous. 2. According to the insertion of their stamens, which is hypogynous or perigynous. 3. According to the adhesion or non-adhesion of their calyx with the ovarium, which

is either superior or inferior. 4. According to the position of the stamens with respect to the petals. 5. According to the structure of the fruit. 6. According to the structure of the seed. And 7. According to the modifications of their vegetation, as far as they indicate a corresponding peculiarity in the parts of fructification, which is often the case, and which wonderfully facilitates the acquisition of a knowledge of the natural orders of plants. Thus all Rubiaceæ have opposite entire leaves with intervening stipulæ; all Labiatæ have opposite resinous leaves, without stipulæ; all Leguminosæ have alternate leaves, with stipulæ, and leaflets always jointed with the petiole, and, when compound, furnished with stipulæ at the base of each pair of leaflets.

80. Monocotyledones are also subdivided according to the above principles, as far as they are applicable to them, but as this group is much more simple in its structure, and less extensive than dicotyledones, the mode of its division is necessarily different. Its principal section is that of cryptogamiæ, which is characterised by the absence of apparent flowers.

81. Acotyledones, which contain the plants of the simplest structure, have no sexes, but reproduce themselves by what are called sporules, that is to say seedlike bodies, which differ from seeds in germinating indifferently from any point of their surface, and in not being the result of sexual contact. This group answers to the Linnæan cryptogamia, excluding filices.

82. From this statement of the principles upon which the natural system of plants has been contrived, it must be obvious that the difficulties which the advocates of the Linnæan method pretend that it offers to the student do not exist, and that, in fact, the difficulties in the application of the Linnæan method are much greater, as far as the mere student is concerned. In the Linnæan system nothing is learned in the investigation of the name of a plant, except the simple and often very unimportant fact, that its stamens or styles exist in a certain quantity or position; in the natural method, on the contrary, the same process brings the student acquainted, not only with all the characters of that plant which is under his consideration, but also with a comparative knowledge of those plants to which it is allied by nature. In the Linnæan system no step can be advanced till the flower is examined; in the natural method almost any other part of the fructification, and often the foliage or habit of the plant only, will suffice. The Linnæan system produces empirical botany, the natural method scientific botany.

83. It will be seen that, except with reference to the two modern systems of botany, the history of the science, since the time of Linnæus, is here scarcely noticed. The facts and actors since that period are too recent to require explanation, and too much connected with living writers to make a task requisite which would necessarily be ungrateful. After the decease of that great man, a long interval elapsed, which has reached even to our own times, during which but little improvement in the science took place among his followers. They have added, indeed, to the number of recorded plants, by describing and defining according to the principles of their master; but it is to France, and to the disciples of the French school elsewhere, that we must look for the progress of scientific botany.

84. By the united endeavours of the followers of the two systems, the advance of botany, since the days of Linnæus, has been most extraordinary. The number of plants of all denominations now recorded, cannot fall short of 100,000. The elegance and the classical form bestowed upon the science by the labors of the learned Swede, and the attractions offered by the more philosophical principles of Jussieu, and of the French school of botany, have given to the study of the vegetable world that rank among the sciences which its actual importance demands. Princes and potentates have become its patrons, and nobles its professors; vast sums have been expended in its support by the governments of Spain, of France, of the various German states, of Denmark, and of Russia; and in Great Britain the private munificence of individuals has amply compensated for the indifference of the government. The advantages arising from such powerful aid have not disappointed the expectations entertained from them; and the rapid progress of the science towards perfection has amply justified the patronage it has received.

85. But great as the progress of modern systematic botany has undoubtedly been, the progress of modern physiological botany is perhaps still greater. For to give an idea of the mass of talent that has been directed to the elucidation of this difficult department of the study of vegetables, since the period of the investigations of Grew and Malpighi, it will be sufficient to mention, in addition to the name of Linnæus, that of Hales, Bonnet, Du Hamel, Hedwig, Spallanzani, each of whom has peculiarly distinguished himself in the field of phytological investigation, and eminently contributed to the advancement of the science. But Dr. Priestley deserves to be particularised, as being the first who introduced into the study of phytology the aid of pneumatic chemistry, which, under the happy auspices of Ingenhouz, Sennebier, Saussure, and others, has done more to elucidate the phenomena of vegetation, than all other means of investigation put together; so that our knowledge of the physiology of vegetables may now be regarded as resting upon the foundation of a body of the most incontrovertible facts, and assuming a degree of importance inferior only to that of the physiology of animals.

86. But although the labors of phytologists have been directed with success to the explication of a variety of the most important phenomena of vegetation, and although we have been already favored with a condensed and systematic view of the result of their investigations by writers of the highest celebrity, yet there seems to be still wanting some work that shall exhibit them more in detail, and serve the purpose not merely of a brief and rapid sketch, to assist the recollection of the adept, but of a clear and copious introduction, to facilitate the studies of the novice, by presenting to him: first, such an elementary view of the vegetable kingdom, in general, as shall be directly preparatory to phy-

siological research; and secondly, such a view of the process of vegetation as shall render the rationale of the preceding phenomena preparatory to that of the following, and shall not necessarily suppose any previous knowledge of the subject.

III. The Anatomy and Physiology of Plants.

87. Without entering, in this division of the subject, into all the differences of opinion with which botanists have occupied the world during the slow journey by which we have arrived at the present state of our knowledge, it will be enough to explain, in a clear and sufficient manner, those principles of vegetation, and laws of vegetable increase, which are now believed to be correctly ascertained. In this department, the writings of Aubert du Petit Thouars, a distinguished French philosopher, are considered as those which contain the most correct views of the progress of nature.

88. Not to occupy ourselves with the immense variety of forms which cover the whole face of the globe, it will be more convenient, and equally useful, to confine our attention to a single species. For this the commonest weed will answer the same purpose as the stateliest tree of the tropics.

89. After considering its external organs, let us examine its interior, and seek to discover the manner in which they contribute to its existence. By comparing it with other plants, we shall be enabled to determine what it has in common with them, and what are its peculiarities; thus we shall at once acquire an idea of its essential characteristics, and of its differences. By enlarging a little upon the functions of all the organs of a plant, under this part of our article, it will be only necessary under the head of Pure Botany to enter into the modifications of organs, without further reference to their nature and purposes.

90. Take a plant at hazard, the first you meet with by the path; it will be found to possess a root, which fixes it to the ground, and which buries itself in the earth; and a trunk, or stem, which elevates itself in the air. The latter is furnished, at intervals, with leaves which are remarkable for their thinness, and their green color. Near the point where they leave the trunk, is placed a body which is protruded from it also. Without any determinate figure at first, it gradually developes, and produces new leaves similar to those from which it proceeded; and, gradually separating the leaves from each other, it stops by forming a second stem. This stem is a branch. Each new leaf being supplied with a similar body, or bud, is capable of producing a new branch, unless prevented by injury or accident. This, therefore, is the plan upon which the plant we are examining increases in size; but the changes of this nature which it undergoes have little effect upon its peculiar characteristics, they only render it of greater or smaller size. But a more remarkable epocha presently arrives. Buds make their appearance of a very different nature from those which formerly produced branches; they insensibly increase in size, and at a fitting hour, when they have arrived at their greatest growth, the delicate parts which they contain, burst through the scales which envelope them, and expand themselves; these are the flowers. They are no longer of a monotonous uniform green color, but they assume the most lively hues, they exhale the most delicious fragrance, and they surprise us by the complex mechanism which they contain. But their duration is brief. Of all the parts of which they were composed, one only remains, which is the pistillum and which fills the centre. When all the rest are withered, this alone assumes a new life, and, after a gradual increase in size arrives at maturity, and becomes the fruit. The latter encloses bodies which separate from it at the period of maturity, and which are the seeds.

91. Each of these seeds placed in the earth, and submitted to the effects of time and circumstances, undergoes the process of germination; that is to say, absorbing, or, as some have it, pumping up humidity, througn cnannels which are invisible to our senses, it swells until it bursts through the coverings in which it is encased. Then a new body makes its appearance. This is the embryo or rudiment of a new plant; it is formed of two portions; the one a cylindrical or conical oblong body, and the other two leaf-like processes applied closely upon each other. The cylindrical body lengthens, and endeavours to bury itself in the earth; whatever may be the position in which the seed is placed, it finally attains this purpose, and, penetrating the soil, becomes a real root; whence the name of radicle, which is applied to this organ when in a state of rest. The two leaf-like processes separate, and assume a horizontal direction; they are the cotyledons. In their centre is to be seen a sort of little bud, which is called the plumule, and which is the parent of subsequent leaves; those which it first developes are rather different from those of the plant which produced itself; but in the end they become identical, and a new plant is produced, in all respects the same as that by which the seed was originally borne.

92. Having now examined the exterior of a plant, it is time to consider its internal structure. For this purpose it is as well to continue our observations on the little plant which has just emerged from the seed. In its state of infancy and seclusion, the radicle, when cut across, offers nothing more than a succulent homogeneous substance. As soon as it has advanced, and touched the earth, and pushed forth some young roots, if it is broken across it will be seen that it is then divided into two distinct parts; namely, a cylinder covered over with a sheatn, which appears capable of being separated from it in all points. If the plant has also produced young branches, they too, when cut across, exhibit a similar appearance; that is to say, upon their first coming forth they will be found solid and homogeneous, and presently afterwards they will be seen to consist of a solid cylinder, and of an external case. After all these parts have arrived at a further period of their growth, another difference will be observable. A transverse section then exhibits two concentric circles; the

inner enclosing a spongy and rather dry cylinder, the exterior a sheath, which is firmer and of a whitish color; besides which will be seen the separate case which was distinguishable from the earliest development of the plant, and which has now become whitish in the inside, but which retains externally its succulent texture and green color. The rest, however, continues to manifest its two original divisions only, which are always white or some other color, but never green.

93. Here then we have three distinct parts, that in the centre is the pith, the case which surrounds it is the ligneous substance, or the wood; and the external covering is the bark. In the root the pith is absent. But are these parts actually as distinct as they appear to be to the naked eye? In the infancy of the plant we have seen that they were not separate. By what means then have they become so?

94. At the period when they appear most distinct let us examine the pith with a pocket lens. We shall perceive that it consists of a mass of little bladders, or cells, the section of which exhibits a figure more or less hexagonal, and which constitute polyhedral figures, the sides of each of which appear to be common to two cells. They are not so, however, in fact; each polyhedral cell being, as is now known, distinct and separable from those next it, with which it is only in a state of cohesion. Following the direction of these cells with care, it will be seen, that some of them pass horizontally through the ligneous substance, and lose themselves in the bark; if no trace of these appears on the surface of the wood when the bark is stripped off, that will be attributable only to the extreme tenuity of the traversing cells, which snapping asunder upon the slightest violence, leave no perceptible vestige, and offer no sensible resistance. If they are traced in the bark itself, it will be found that they maintain a connexion with the external part of it, where they form a continuous layer, which is what preserves that green color which is always obvious on the outside.

95. The only difference which exists between these parts is, that the centre has expended all its juices, and that the outside of the bark preserves them. In this state the latter receives the name of parenchyma. But with the feeble nature, and slight texture which it possesses, in what manner can it be conceived that the pith penetrates the woody substance which seems to be so solid? The first glance is sufficient to explain this phœnomenon. There is no sort of difficulty in seeing that the wood is composed of parallel fibres, which interlace each other, and form a kind of net-work, through the meshes of which the parenchyma, or the medullary elongation, finds its way to the bark. There it meets with a net-work of matter far more flexible than that nearest the pith, and composing all the interior of the bark; this latter is named the liber.

96. There is still an essential part of the bark to notice, which is the epidermis. This is easily discovered. All the interior parts of a plant seem both to the eye and the touch saturated with glutinous juices, while the external part is wholly dry. This state of dryness arises with the epidermis, which consists of an exterior membrane, enclosing and holding together all the solid and fluid parts. It originally existed in the embryo, and it continues to cover, without interruption, all the parts subsequently developed. Even the leaves themselves, so delicate and attenuated, are covered over both surfaces with two united skins of this epidermis. The expansion or dilatation to which they are subject proves this fact, and makes them excellent evidences of it.

97. The part by which the leaf is attached to the stem, and which is named the petiole, appears to be composed of a bundle of fibres. The petiole extends from one end to the other of the leaf, and separates it into two nearly equal parts. It diminishes in diameter as it approaches the end of the leaf, because it from time to time sends off young branches from each side, which themselves become subdivided, and, by crossing each other in various directions, form a kind of continuous net-work.

98. Accident, insects, or a very sharp instrument, will separate the epidermis. It then appears in the form of an extremely thin and perfectly transparent membrane. The green color which it exhibits in its natural state, is not proper to itself, but is caused by the succulent substance which is interposed between the meshes of net-work. In the latter there is no difficulty in recognising the parenchyma in a state of vegetation; for it is certain that the green color is the constant attendant of that state, and that by its means the parenchyma may be discovered wherever it exists.

99. The fibres which form this net-work proceed from the petiole; but whence does the petiole itself derive its origin? It appears to spring from the bark; in that case would it be any thing more than the meshwork of the liber in a state of development? Such has been the opinion of some writers; but, if its origin be carefully traced, it will be found to arise within the woody substance itself; and to be in fact a detached portion of the wood.

100. The phenomena which took place at the period of germination are renewed by every leaf which successively unfolds itself. The cotyledons were the source of the fibres which were sent down into the earth through the root; in like manner every leaf is enabled to maintain a communication between itself and the soil by the means of fibres. Hence arises another kind of increase, of which no notice has yet been taken; the increase in thickness. A stem which at the hour of its birth was no thicker than a pin, in a few months acquires the diameter of an inch or more. This arises from the successive superposition of the bundles of fibres, which are created upon the development of each leaf, and of every leaf-bud. The latter makes its first appearance under the form of a green point, which originates from the inner layers of the ligneous body, which it traverses, and penetrates into the bark. A short time after its first appearance, it may be perceived that the bud is surrounded by a portion of woody fibre, which passes downwards, covers over the wood previously formed, and thus forms a new layer. The existence of

this is easy to demonstrate; for the fibres of the leaves separate easily from the wood, but the leaf-buds when broken off evidently arise from the interior of the wood. All the new parts formed by the leaf-bud soon become so completely identified with the old wood, that, after a short period, no marks of separation remain.

101. We have now followed the plant through all its stages of increase. We have next to consider what the source is from which it has obtained the substances it has assimilated. There can be no doubt that the roots, which penetrate into the earth, contribute much to this purpose; for a long time, indeed, it was believed that plants were capable of absorbing even earth itself. But more accurate observation has shown that nothing but humidity can be carried up into the plant through its roots. Mere humidity, however, is insufficient to maintain life and health in a plant. Experiments have been tried to induce plants to exist with their roots plunged into water only: they all proved abortive, although in some cases life was maintained in the subjects of the experiments for several years. Various substances or agents, in combination with humidity, doubtless afford the nutriment upon which vegetables live. But by what curious mechanism is the requisite humidity conveyed to the parts which require it?

102. In the rapid coup d'œil which has been cast upon the internal structure of plants, we have perceived nothing more in the ligneous body and the liber of the bark, than elongated fibres, which cross each other and form a net-work. Of this we may be convinced with little trouble, by examining against the light, with a pocket lens, a very thin transverse section of a branch. It will be seen to be pierced full of holes, of different forms and sizes; these are the extremities of as many continuous tubes. The true structure of these tubes is much a matter of conjecture and dispute; some observers discover an infinite variation of figure and organisation; others reduce them all to the woody fibre and the spiral vessels or tracheæ. While one microscopic botanist sees pores and holes in the sides of these tubes, simple tubes, mixed tubes, and many more; others declare that the pores are imaginary, the difference nonexistent, and that all the tubes are essentially the same. In this war of observation, which, however curious as a matter of speculation, bears very little upon the most important part of vegetable physiology, or upon the functions of parts, we shall at present content ourselves with one kind only, which is easy to observe. Twist a young shoot so as to break it with as little violence as possible, and the two separated parts will be found to be held together by extremely delicate threads. If you consider them with care you will find that they are each one a simple thread, rolled up in an admirable manner in the way of a corkscrew. The spires of this screw being closely applied to each other, it forms a continuous tube; vessels of this kind are called spiral vessels and are found in the nerves of the leaves, or in the bundles of vessels in communication with the leaves. It was long thought that in these parts a striking analogy was perceptible between animals and plants; and a comparison was drawn, apparently with reason, between the spiral vessels of plants, and the tracheæ of animals, especially of insects which are constructed in a very similar manner. It was, therefore, inferred, that these were the respiratory passages of plants, but experience has not confirmed this notion. Nevertheless, it is certain, that air acts a great part in the economy of vegetation, and that it is by the leaves that its influence is manifested. They have a direct communication with the roots, whither all their intermediate tubes extend; and the pores which terminate them may be seen with different degrees of facility acording to circumstances. By their agency, the humidity which is sucked from the earth is raised and forms what is called sap, which deposits successively all that is necessary for the supply of the different parts through which it passes. Having arrived at the leaves, a portion escapes by perspiration, a portion is deposited, and the remainder descends, charged with new principles, which the leaves have absorbed from the surrounding atmosphere. The leaves therefore contribute to the increase of the plant. When this motion of the sap is once established it continues to increase; and it is supposed that the superfluous power which it has acquired occasions the production of new branches, and of flowers.

103. But what is the cause of this motion? The most obvious is heat, which, by dilating those upper points, which are most subject to its action, occasions a void in them; the juices which are below them ascend to replace the void, and the continual recurrence of this operation occasions what we call the circulation or motion of the sap. This mechanical action will be a sufficient explanation for those who are contented with looking only at the surface of things; but it will not explain all the difficulties connected with the motion of the sap; and, especially will it not account for the first tendency of the radicle to the earth, on which tendency all subsequent phenomena necessarily depend; of such a tendency, gravitation and a thousand other laws have been offered as an explanation, each being more unsatisfactory than the other. Surely it is wiser at once to admit that it depends upon that inherent principle of life which is peculiar to organic matter, which accompanies the vegetable through all stages of its existence; and which is infused into those new individuals which the parent produces. It is a first impulse received in the beginning of its existence, which has extended into every part, and which finally passes into the seeds. It is that first creatric impression to which it owes the faculty of assimilating the various moleculæ of matter, and of applying them; by whose influence the roots are directed towards the side where the most fitting nourishment is to be found; which compels the leaves to present their upper surface always to the light; which induces many to assume that peculiar position during the night which has been compared to the sleep of animals; and finally which gives rise to those various phenomena of vegetation which seem to distinguish plants from the general laws of physics.

104. This, perhaps, would be the proper place

to consider the relation which is borne by this vital principle of plants, to that life which we ourselves enjoy, and which we see descending in the scale of creation, growing weaker and weaker as it approaches the inferior animals, of which in general it appears to be the attribute. But, as we can be guided in this labyrinth by force of reasoning only, this question belongs less to the department of natural history than to that of metaphysics.

105. There are many other instructive ideas which may be obtained from the consideration of a single plant; but they perhaps, will be best understood by a comparison with other plants; and by ascertaining by that means, whether all are formed upon the same plan, composed of the same parts, and subject to the same changes.

106. One of the most obvious contrasts presented by the vegetable kingdom, is between the tribes which rapidly expand their foliage, and push up their flower-bearing stems, and by bringing their fruit to perfection fulfil the purpose of their creation in the space of a few months, or even weeks, and those monarchs of the forest which bear aloft their majestic branches in the air, and see centuries passing by them, while generation after generation of herbs, and even men, are perishing at their feet. One would think that if anything could indicate a difference of organisation it would be peculiarities like these. In fact, if we examine one of these vegetable colossi, which storms or other accidents have levelled with the earth that was so long overshadowed by its branches, we perceive that its interior consists of a solid, compact, homogeneous substance, which seems to be analogous to nothing in the annual plant; we also see, however, that a section of this substance is marked by concentric circles. In order to ascertain the origin of these circles, it is necessary to revert to the seeds, which such a tree produces in vast abundance. There we discover the same parts as in the annual plant; two cotyledones; a cylinder, which attempts to fix itself in the earth by the production of roots; and an intermediate bud. The impulse once given to its developement, this seed, with its apparently feeble resources, will become in the lapse of years and ages similar to that giant which produced it. In the leaves and buds consist the sources of its magnitude. The former being under the necessity, on the one hand of coming into contact with air, and on the other of establishing a communication with the soil, establish the action of vegetation. The first year passes on as in the annual plant, except that the parts of the tree are unfolded with less rapidity and that the buds present neither flowers nor fruit, but a tree covered with scales. Upon the arrival of winter, the annual perishes, the tree loses only its leaves. As soon as the season again becomes milder, vegetation, which had been suspended, is renewed; the buds insensibly expand, and the unfolding of new leaves gives a new life to the plant; each of these leaves is accompanied by its bud. Thus each successive season, producing a mass of foliage, which increases by a rapid geometrical progression, and an equal number of new buds, occasions the formation of a new body of ligneous substance, which overlays the old body, and thus forms the whole tree into a kind of cone.

107. The whole mass of the wood is thus composed of thin successive cones. They are easily perceived in many trees, and it is they which form those concentric circles observable in a trunk cut across. Each circle, depending wholly upon the increase caused by the return of successive seasons, becomes a sure testimony of the age of the tree.

108. The principal part of our trees exhibits these laws of development. The buds may be more or less apparent; and the scales which enclose them may be more or less numerous, being increased in number in proportion to the greater sensibility of the organs they enclose. For a more sure protection, the scales are often covered with glutinous or resinous exudations. But even with this safeguard, the fostering hand of nature does not rest. Thick furs are frequently interposed during the winter among the buds, and are thrown over the tender shoots.

109. By this means the buds remain safely upon the tree. We generally remark one which is a termination of the branch, and which will the following year prolong the branch in its original direction; all the others are seated at the axillæ of the leaves.

110. Trees present many peculiarities, which depend upon their woody state. The pith, which occupies the centre of young plants, disappears in trees. It is probable that, besides the increase in diameter which takes place externally, some peculiar operation goes forward in the inside, and that the solid layers of wood compress the pith in such a way as to leave scarcely any traces behind. Around it vegetation is evidently maintained for a long time, as is shown by the green tinge which surrounds it. Larger and more obvious vessels are placed about it than elsewhere, and constitute what is called the étui medullaire by the French, which there is reason to think is one of the most important accessories of vegetation.

111. The wood does not at once arrive at that solidity which it subsequently possesses, but acquires it by slow degrees, from the centre to the circumference. For this reason the external layers are much less compact, and paler than the internal; they are called the alburnum. Dutrochet accounts for this difference in the old and new layers of wood with his usual sagacity. He is of opinion that a portion of the sap, elaborated and sent downwards by the leaves under the state of proper juice, is absorbed laterally by means of the radiating vessels, or silver grain, and is gradually deposited in the originally empty vessels of the wood; that the compactness and weight of wood depends upon these juices so deposited, and not upon any constitutional difference in the wood itself, and that in certain trees, which are remarkably light, as the poplar, no deposit, or scarcely any, takes place.

112. The bark also undergoes material changes in the course of time. The first branches which are produced are green, like the leaves; their color being occasioned by the transparency of the epidermis, which allows the cellular tissue, or the parenchyma, to show through. By slow de-

grees the epidermis thickens, and assumes a deeper color, under which appearance it is seen in the winter season. If it is raised up, the green color of the parenchyma is still manifest enough beneath it. The epidermis necessarily gives way gradually to the growth of the tree, and splitting in various directions is replaced by another; and by slow degrees new layers are formed, and burst in various directions. According to the nature of the plant the epidermis also takes a variety of forms, sometimes forming the misshapen knotty crust which is usually called bark, sometimes peeling off in thin layers, and occasionally falling from the parent tree in hard flakes.

113. It is probable that the bark performs the same functions as the leaves, in the early state of the buds, and occasionally in all states. Otherwise it would not be easy to account for the growth of cacti, euphorbias, some apocineous plants, &c. which are all destitute of leaves. In fine, the bark may be compared to a universal leaf, with one surface only.

114. We have seen what ingenious methods nature adopts to screen the buds from the rigor of winter; but in countries where there is no winter no defence is requisite. These protecting scales diminish therefore, by degrees, as we approach the equator. In the trees which cover countries in such a latitude, the buds break forth at once into leaves and branches, without regarding the order of seasons. By this circumstance the apparent difference between trees and herbs is removed.

115. In like manner, insensible gradations unite the herbs which creep or trail along the ground, and those which carry their heads aloft in the air: the perennial and the annual vegetable. Some exist for two years. The stems of others perish every year, but their roots survive. Some under shrubs scarcely elevate themselves from the soil, yet their slender stems are formed of a firm and woody substance. Next come the shrubs whose branched and entangled stems form bushes. Lastly are perfected the trees which from possessing a stem scarcely loftier than the stature of a man, finally dilate themselves till they become the giants of the forest.

116. We have assigned, as the cause of increase in the bulk of trees, the communication which is established in their system between the leaves and roots. The reciprocity of disposition of these two organs is so strong, that if a bit of a branch of any tree which is robust enough to bear the operation, be placed in the earth it immediately makes good the loss it has sustained by being dissevered. It presently produces fresh roots, and a new plant is formed. The advantage which is taken of this peculiarity of plants, to propagate them by cuttings or layers is well known. But this is not all; a bud separated from its parent, and inserted between the bark and the wood of another tree, soon establishes the requisite communication between itself and the earth, and renders the tree which bears it similar in nature to the kind artificially inserted. Hence the origin of budding and grafting in horticulture.

117. From these observations it has become evident, that the life of a plant is a succession of several lives; and that the greater proportion of its parts consists of an intermediate system, which only serves to maintain a communication between the extreme points of the vegetable. If a tree is destroyed by the ravages of time, its death can be only occasioned by the destruction of the intermediate portions of its fabric, by which the channel of continuous communication is effectually interrupted. After such interruption has taken place, the still surviving portions of the tree are capable of furnishing layers or cuttings, which will renew the operation of vegetation with unabated vigor.

118. The resources of nature are far from being exhausted by these apparent buds; there exists throughout the vegetable system a creative and expansive power, which, according to circumstances, is able to operate in the development of new buds, where none had been visible before. In fact, there is always an abundance of rudimentary buds dispersed among the substance of a tree, which are only called into action when the ordinary resources of nature begin to fail. They are frequently excited very long after the period which had been originally assigned for their appearance; and even in places where no traces of them could have been expected to exist. Thus in all vegetables there appears to be as obvious a line of demarcation in the system, at that point which is called the collar, whence the first ascending fibres direct their course upwards, and the descending downwards. Buds are only produced by the former, and form no part of the economy of the latter. Yet it not unfrequently happens, that roots exposed in a proper degree to the influence of the air, will form buds, and throw up shoots, in the same way as the branches. Even the leaves have, in a few cases, a similar power of producing buds, and consequently young plants.

119. We have now seen that the growth of plants, and their increase in size, depends upon a peculiar internal movement, acting between the leaves and the roots. But in what way does it operate? This is a problem which has exercised the ingenuity of all students of vegetable physiology, who have contrived theories innumerable to explain the phenomenon, which is called the circulation of the sap.

120. The great and almost impenetrable obscurity in which this subject is unavoidably involved, has occasioned much diversity of opinion among phytologists. Grew states two hypotheses, which he seems to have entertained at different periods, though it is not quite certain to which of them he finally gave the preference. In one of them he attributes the ascent of the sap to its volatile and magnetic nature, aided by the agency of fermentation; but this hypothesis is by much too fanciful to bear the test of serious investigation. In the other he attributes the entrance and first stage of the sap's ascent to the agency of capillary attraction, and accounts for its progress as follows: the portion of the tube that is now swelled with sap, being surrounded with the vesiculæ of the parenchyma, swelled also with sap, which they have taken up by suction or filtration, is consequently so compressed, that the sap therein is forced upwards a second stage, and so on till it reaches the

summit of the plants. But, if the vesiculæ of the parenchyma receive their moisture only by suction or filtration, it is plain that there is a stage of ascent beyond which they cannot be thus moistened, and cannot, consequently, act any longer upon the longitudinal tubes. The supposed cause, therefore, is inadequate to the production of the effect.

121. Malpighi was of opinion that the sap ascends by means of the contraction and dilatation of the air contained in the air-vessels. This supposition is perhaps somewhat more plausible than either of Grew's; but, in order to render the cause efficient, it was necessary that the tubes should be furnished with valves, which were accordingly supposed; but of which the existence has been totally disproved by succeeding phytologists. If the stem or branch of a plant is cut transversely, in the bleeding season, it will bleed a little from above as well as from below: and if the stem of any species of spurge is cut in two, a milky juice will exude from both sections in almost any season of the year. Also if a plant is inverted, the stem will become a root, and the root a stem and branches, the sap ascending equally well in a contrary direction through the same vessels; as may readily be proved by planting a willow twig in an inverted position. But these facts are totally incompatible with the existence of valves; and the opinion of Malpighi is consequently proved to be groundless.

122. The next hypothesis is that of M. De la Hire, who seems to have attempted to account for the phenomenon by combining together the theories of Grew and Malpighi. Believing that the absorption of the sap was occasioned by the spongy parenchyma, which envelopes the longitudinal tubes, he tried to illustrate the subject by means of the experiment of making water to ascend in coarse paper, which it did readily to the height of six inches, and by particular management even to the height of eighteen inches. But, in order to complete the theory, valves were also found to be necessary, and were accordingly summoned to its aid. The sap which was thus absorbed by the root, was supposed to ascend through the woody fibre, by the force of suction, to a certain height; that is, till it got above the first set of valves, which prevented its return backwards; when it was again supposed to be attracted as before, till it got to the second set of valves, and so on till it got to the top of the plant.

123. This theory was afterwards adopted by Borelli, who endeavoured to render it more perfect, by bringing to its aid the influence of the condensation and rarefaction of the air and juices of the plant, as a cause of the sap's ascent. And on this principle he endeavoured also to account for the greater force of vegetation in the spring and autumn; because the changes of the atmosphere are then the most frequent under a moderate temperature; while in the summer and winter the changes of the atmosphere are but few, and the air and juices either too much rarefied, or too much condensed, so that the movement of the sap is thus at least prejudicially retarded, if not perhaps wholly suspended. But as this theory, with all its additional modifications, is still but a combination of the theories of Grew and Malpighi, it cannot be regarded as affording a satisfactory solution of the phenomenon of the sap's ascent.

124. With this impression upon his mind, and with the best qualifications for the undertaking, Du Hamel directed his efforts to the solution of the difficulty, by endeavouring to account for the phenomenon from the agency of heat, and chiefly on the following grounds: because the sap begins to flow more copiously as the warmth of spring returns; because the sap is sometimes found to flow on the south side of a tree before it flows on the north side; that is, on the side exposed to the influence of the sun's heat sooner than on the side deprived of it; because plants may be made to vegetate even in winter, by means of forcing them in a hot-house; and because plants raised in a hot-house produce their fruit earlier than such as vegetate in the open air.

125. On this intricate but important subject, Linnæus appears to have embraced the opinion of Du Hamel, or an opinion very nearly allied to it, but does not seem to have strengthened it by any new accession of argument, so that none of the hitherto alleged causes can be regarded as adequate to the production of the effect.

126. According to Saussure, the cause of the sap's ascent is to be found in a peculiar species of irritability, inherent in the sap vessels themselves, and dependent upon vegetable life; in consequence of which they are rendered capable of a certain degree of contraction, according as the internal surface is affected by the application of stimuli, as well as of subsequent dilatation, according as the action of the stimulus subsides: thus admitting and propelling the sap by alternate dilatation and contraction. In order to give elucidation to the subject, let the tube be supposed to consist of an indefinite number of hollow cylinders, united one to another, and let the sap be supposed to enter the first cylinder by suction, or by capillary attraction, or by any other adequate means; then the first cylinder, being excited by the stimulus of the sap, begins gradually to contract, and to propel the contained fluid into the cylinder immediately above it. But the cylinder immediately above it, when acted on in the same manner, is affected in the same manner; and thus the fluid is propelled from cylinder to cylinder, till it reaches the summit of the plant. So also, when the first cylinder has discharged its contents into the second, and is no longer acted upon by the stimulus of the sap, it begins again to be dilated to its original capacity, and prepared for the intro-susception of a new portion of fluid. Thus a supply is constantly kept up, and the sap continues to flow.

127. But Mr. Knight has presented us with another, which, whatever may be its real value, merits at least our particular notice, as coming from an author who stands deservedly high in the list of phytological writers. This theory rests upon the principle of the contraction and dilatation, not of the sap vessels themselves, as in the theory of Saussure, but of what Mr. Knight denominates the silver grain, assisted

perhaps by heat and humidity, expanding or condensing the fluids. On the transverse section of the trunk of woody plants, particularly the oak, they appear in the form of the radii of a circle, extending from the pith to the bark; and on the longitudinal cleft or fissure of the trunk of most trees, but particularly the elm, they appear in the form of fragments of thin and vertical laminæ, or plates, interlacing the ascending tubes in a transverse direction, and touching them at short intervals, so as to form with them a sort of irregular wicker-work, or to exhibit the resemblance of a sort of web. Such, then, being the close and complicated union of the plates and longitudinal tubes, the propulsion of the sap in the latter may be easily accounted for, as it is thought, by means of the alternate contraction and dilatation of the former, if we will but allow them to be susceptible to change of temperature; which susceptibility is proved, as it is also thought, from the following facts: on the surface of an oaken plant that was exposed to the influence of the sun's rays, the transverse layers were observed to be so considerably affected by change of temperature as to suggest a belief that organs which were still so restless, now that the tree was dead, could not have been formed to be altogether idle while it was alive. Accordingly, on the surface of the trunk of an oak deprived of part of its bark, the longitudinal clefts and fissures, which were perceptible during the day, were found to close during the night. But in the act of dilating they must press unavoidably on the longitudinal tubes, and consequently propel the sap; while in the act of contracting they again allow the tubes to expand and take in a new supply. This is the substance of the theory.

128. But, in drawing this grand and sweeping conclusion, Keith has well remarked, that it should have been recollected, that change of temperature cannot act upon the transverse layers of a tree that is covered with its bark, in the same manner as it acts upon those of a tree that is stripped of its bark, or upon those of a plank; and if it were even found to act equally upon both, still its action would be but of little avail. For, according to what law is the machinery of the plates to be contracted and dilated, so as to give impulse to the sap? According to the alternate succession of heat and humidity? But this is by much too precarious an alternation to account for the constant, and often rapid, propulsion of the sap, especially at the season of bleeding. For there may be too long a continuance of heat, or there may be too long a continuance of humidity; and what is to become of the plant during this interval of alternation? If we are to regard it as happening only once in the space of twenty-four hours, as in the case of the oak, it can never be of much efficacy in aiding the propulsion of the sap. But if we should even grant more, and admit the alternate contraction and dilatation of the vessels to be as frequent as you please, still their effect would be extremely doubtful, owing to a want of unity or co-operation in the action of different plates, or of different portions of the same plate. If heat, like humidity, entered the plant by the root, and proceeded gradually upwards, like the ascending sap, perhaps it might be somewhat efficacious in carrying a portion of sap along with it; but as this is not the case, and as the roots of plants are but little affected by change of temperature, while the trunk and upper parts may be affected considerably, it can scarcely be supposed that the action of the plates will be uniform throughout the whole plant; or rather, it must be supposed, that it will often be directly in opposition to that which is necessary to the propulsion of the sap. But, admitting that the sap is propelled by the agency of the plates in question, and admitting that it has been thus raised to the extremity of the woody part of the plant, how are we to account for its ascent in such parts as are yet higher; the leaf-stalk and leaf, the flower-stalk and flower; as well as in the herb also, and in the lofty palm, in which no such plates exist? Here it will be necessary to introduce the agency of a new cause, to complete the work that has been thus begun, and of a new set of machinery to supply the deficiency or absence of the machinery that has been already invented.

129. How unsatisfactory the best of these theories is, must be self-evident, even to persons unacquainted with the structure of vegetables. Du Petit Thouars has, therefore, with his accustomed ingenuity, proposed a new hypothesis, which to us seems by far the least objectionable which has yet been contrived. He dismisses the question of the mechanical action by which the motion of the sap is maintained; thinking, with much justice, that no principle of physics, with which we are acquainted, is sufficient to explain it; and he therefore attributes the mere motion to an inherent power, with which nature has been pleased to endow vegetables. But the cause of the renewal of its motion in the spring, after remaining in a quiescent state for several months, he ascribes to the necessity of maintaining a perfect equilibrium in the system of a plant. So that, if a consumption of sap is produced at any given point, the necessity of making good the space so occasioned, consequently throws all the particles of sap into motion, and the same effect will continue to operate as long as any consumption of sap takes place. The first cause of this consumption of sap he declares to be the development of the buds, and already formed young leaves, by the stimulating action of light and heat, but particularly of the latter. As soon as this development occurs, an assimilation and absorption of sap is occasioned, for the support of the young leaves; a vacancy in the immediate vicinity of the leaves is produced, and motion immediately takes place.

130. We will not occupy ourselves with an explanation of the cause of the descent of the sap: gravitation will serve the purpose, in the room of a more plausible conjecture.

131. But, notwithstanding all the differences which exist among trees, they approach each other by insensible degrees; and yet they individually retain a peculiar set of characters, and a physiognomy, which botanists call habit, that renders it easy to distinguish them at great distances; and more easy to eyes habituated to the

sight of them, by practice and long familiarity, than by the aid of theory.

132. Hot countries are beautified, however, by a description of tree, the differences of which are exhibited in an unusual degree. In these regions exist the palms, that patrician order of plants, as Linnæus termed it, which supports an umbrageous undulating tuft of huge leaves, seated on the summit of a lofty columnar trunk. Here you have no longer an infinite division of branches, as in our trees of Europe, but a trunk of the greatest possible simplicity, covered with rigid scales, or marked by distant circles. If an observer notices a considerable number together, of different ages and sizes, he will perceive that the smallest and the youngest are entirely the same as the largest, except in dimensions. They possess an equal quantity of leaves, their trunks are of equal diameter, and they differ only in stature. Carrying observation yet farther, it will be found that the trunk is not formed, as in European trees, of concentric circles of wood, but that it is formed by the assembly of a vast number of parallel fibres, which extend from the roots to the summit, and every one of which has its communication with a leaf. No trace of pith is discoverable in the centre, nor of liber or bark in the circumference; but the whole body of utricular or parenchymatous matter exists dispersed among the fibres.

133. To understand this peculiar manner of growth, recourse must again be had to the seed, and to its germination. This is easily examined, the seed of the palm-trees being often among the largest in nature. The part, however, by which reproduction takes place, is wonderfully small for the size of the seed; and lies hidden in a peculiar substance of great dimensions, which is called the albumen.

134. This embryo is oblong, and manifests no trace of division, or of separation, at either extremity. As soon as the period of germination arrives, the exterior extremity elongates and opens, producing a kind of sheath, from the base of which descends a root, and the other extremity of which is always retained in the albumen. This sheath encloses a second, which is rather longer; a third appears, becoming yet longer and longer; from one of the sides of the next is unfolded a kind of plaited leaf. Following each other in succession, the one from the bosom of the other, they at length assume the appearance of the adult leaves, differing from them only in dimensions. The parts of the leaves, continually dilating, expand, and throw off the scales which first appeared; and this centrifugal dilatation goes on till a sort of foundation is laid, which is incapable of growing in any direction except in breadth. Roots go on increasing under ground. Finally, a kind of base is formed, of a far more considerable diameter than the future trunk, or stipes; which then shoots upwards, and increases regularly in dimensions, by the successive development of leaves. These are enclosed, one within the other, in a peculiar manner, and constitute a bud of a particular description. Each has a tendency to rise to a fixed height above that which contained it; the old leaves, as they complete their functions, either fall off wholly, leaving only a scar behind, or partially, still continuing to clothe the stem with their remains. As soon as this stipes, or trunk, has acquired a certain elevation, bunches of flowers make their appearance in the axillæ. Sometimes they expand among the leaves, as in the date and cocoa nut; sometimes they appear from the stem, as in the areca nut. Although they do not appear till the trees have acquired maturity, they are formed long before. Traces of them may be discovered among the first leaves which are developed; but vegetation, powerfully attracted upwards by the summit, gives them no leisure to unfold themselves, till some check is given to the increase of the tree.

135. We have seen that a section of a dicotyledonous tree presents a series of concentric circles, which are, in fact, the register of its life. The scars or the scales of palms offer a similar, and not less certain, chronology of their past existence; and if you search the interior of their bud, or, as it is often named, their cabbage, which is one of the most delicate of foods, you will find that it is equally easy to read its future history. You will there find, without the aid of glasses, flowers and leaves already formed, which will not be finally produced till several years subsequently.

136. For example, in a species of euterpe, found on the Island of Bourbon, the flowers are visible eight years before they are expanded. The summit is formed of twelve leaves, each supplied with a bunch of flowers in its axilla. These leaves only expand each year, so that four years will have elapsed between the expansion of the first flowers and of the last, although even the former were discoverable four, and the latter eight, years previously.

137. Here, then, we have a mode of germination and development very different from those of European plants. It is not, however, peculiar to palms; but is found, at least in an analogous manner, in a great number of the herbs which are natives of our latitudes. Only hot countries produce other trees with a similar peculiarity of organisation. These differences have given rise to the establishment of two great divisions in the vegetable kingdom. Those plants of which we first treated are called dicotyledons, on account of the two lobes or cotyledons of their embryo; those which have been last under discussion are named monocotyledones, their embryo being provided with one cotyledon only.

138. If it were necessary to have recourse to an examination of the seed, whenever it was necessary to ascertain to which of these two great divisions a given plant belonged, few persons would be found who possess either the patience or opportunity required for ascertaining what is often a very minute point. But, fortunately, this division, which is founded in nature, possesses many external characters, which are quite as available as those of the seed. Before explaining them precisely, we will place two common plants under examination.

139. The first is the common onion. The seed of this plant, like the palm, but of much smaller dimensions, consists of an elongated simple embryo, placed in the midst of albumen.

Its extremity, which is protruded by germination, becomes longer. One end becomes thickened, and buries itself in the soil, whence proceeds the root; the other end is elevated, and bears the seed, like a little cap. Presently a green color pervades it, and we can no longer doubt that it is a genuine leaf. A little above the root is a small lateral slit; from this a second leaf is produced, a third follows, and so on. Each is enclosed within the other, as in the palm; and, like it, they all direct their efforts to produce a kind of base; by these means the dilatation of the root takes place; and, the centre constantly forcing the interior outwards, a true onion is at last the consequence. The leaves, withering up as soon as they have performed their functions, perish, and leave behind them nothing but their fleshy sheaths, the most exterior of which wither and perish also; the interior retain their fleshy and swollen habit. As soon as the period of fructification has arrived, a simple leafless stipes is elevated from the centre of the root, and puts an end to the existence of the individual, except when buds exist among the leaves and give birth to what are called off-sets.

140. The second example, which is equally familiar, shall be that of wheat. The valuable seed which is borne by this herb is, like that of the onion and the palm, formed of albumen, which is what we know under the name of flour, and of an embryo, which reposes at its base. The latter is a little different in figure from the two others; but, like them, it gives rise to a sheath, out of which in succession scales and then leaves arise. At the base of each sheath or leaf, in the inside, is found a bud, which is speedily developed, and contributes to form the tuft of herbage, under which appearance the plant is seen in its earlier stages. But, as soon as the flowering season arrives, a stem of a particular description is produced. Each leaf becomes separated from that which is next it by a considerable space; these spaces are hollow, and partitioned off by a particular kind of division. This kind of stem is called a culm. It is now obvious that there is something peculiar in the manner of growth of the mocotyledons, which distinguishes them from dicotyledons. The leaves, however, offer marks of a more decisive kind. We have already seen, that in dicotyledonous plants, the nerves of the leaf resemble a sort of net-work, but in monocotyledons have a parallel and rectilinear direction, passing without interruption from one end to the other; that is to say, those fibres which are nearest the principal rim, run alongside it as far as the tip, where they are lost in the margin; and all the fibres affect the same direction. Hence the almost constant elongated form of their leaves, which are in some sorts comparable to the blade of a sword, being broadest at the base, and terminating in a point. You rarely can perceive the crenatures, or denticulations, or lobes, which are so common in the leaves of dicotyledons.

141. The flowers also offer some aid in distinguishing these two great classes from each other. The number of parts, which is so variable in most plants, appears almost fixed in monocotyledons. Every organ of fruitification is arranged in a ternary mode, simple or double, or multiple. Dicotyledonous plants are much less constant; nevertheless, the number five, simple or multiple, is more commonly peculiar to them than any other number. It is extremely difficult to assign a cause for this peculiarity; perhaps it is to be sought in the manner in which the fibres first proceed from the parent embryo.

142. Having thus examined the progress of development in the internal parts of a plant, and considered them with relation to their functions, we will conclude the subject of Vegetable Physiology by some remarks upon their variations. We have already seen, that the constituent parts of plants are, cellular tissue, woody fibre, and spiral vessels.

143. The *Cellular Tissue* consists of fine and membranous utricles. Individually, they resemble oblong bladders inflated in the middle, as in the case of some plants; or circular or hexagonal cells, as in the case of others. Collectively, they have been compared to an assemblage of threads of contiguous bladders or vesicles, or to the bubbles that are found on the surface or liquor in a state of fermentation.

144. But this description is applicable to them only as they occur in herbaceous plants; though in either case they are not always of the same figure, in all the different parts of the same plant. In the leaf-stalk of the artichoke, for example, their diversity of figure is very conspicuous, presenting, in their free and uncompressed state, whether on a horizontal or longitudinal slice, a beautiful assemblage of hexagonal cells; but in their crowded and condensed state, as they approximate the longitudinal fibres, an assemblage of tubular threads, successively inflated and contracted. In woody plants their diversity of figure is still greater, as must appear evident if it is but recollected that they constitute not only the bags or bladders of the cellular integument and pith, and of the pulp of the leaf and fruit, but also the very fabric of the divergent layers themselves; assuming a peculiarity of aspect, according to the degree of compression they sustain from other parts; or according to the degree of induration they may have undergone, ascending progressively, from the succulent texture of the pulp and pith to that of the firm and perfect wood.

145. The structure of the utricles of the tree is also said to be different from that of the utricles of the herb; the former being composed of a single membrane, and the latter of a double membrane.. Senebier is, however, of opinion, that they consist of a double membrane in both cases, though not so conspicuous in the one case as in the other, owing to the more compact and condensed texture of the wood. However, they are all mutually connected with one another, and also with the other vessels of the plant; which double union is rendered evident by means of colored injections, or rather by means of the absorption of colored infusions, from which the utricles, as well as the longitudinal tubes, always receive a tinge. But in the petals, stamens and pistils, they do not seem to be connected with the longitudinal vessels, as in the other parts of the plant; and perhaps they are also somewhat

peculiar in their organisation, as may be inferred from the following fact, namely, that the white and milky juice with which they are filled in the stem and branch of the fig does not ascend above the peduncle. In the pith they are generally larger than in any of the other parts of the plant; and in plants from which part of the trunk has been cut off, it has been remarked that they become altogether larger and more inflated than in plants of the same species that have not been so treated; which enlargement is perhaps to be accounted for from the superabundance of sap that now pervades them, in consequence of the diminished bulk of the vegetable. Senebier speaks of other utricles, distinct from those of the parenchyma, by which he means the pulp or pith, but without saying anything explicit on the subject, and without representing them as different in form.

146. The *woody fibre* is made up of tubes of two kinds, which have been distributed into large tubes and small tubes. The large tubes are distinguishable by the superior width of the diameter which they present, on the horizontal section of the several parts of the plant.

147. In herbaceous plants, they are represented, by M. Mirbel, as being always found in the centre of the longitudinal fibres; while in woody plants, they are often dispersed at random; though they occasionally form regular groups, which are sometimes concentric circles, constituting the principal mass of the ligneous layers. They are generally to be found in great abundance surrounding the medullary canal. They are found also in the bark, and are capable of being traced from their origin in the extreme fibres of the root, to their termination in the extreme summit of the plant; uniting in the body of the root, traversing the collar, penetrating and ascending the stem in a parallel direction, separating and entering the branches, buds, and footstalks; separating again, and distributing themselves in smaller bundles, so as to form the nerves and veins of the leaves and petals, the slender fibres of the stamens and pistils, and the firm and woody fibres of the fruit. In the lichens, fuci, and fungi, no large tubes are discoverable, even with the aid of the microscope; though in the transverse section of most other plants they are visible without a microscope.

148. The simple tubes, which are the largest of all the large tubes, are formed of a thin and entire membrane, without any perceptible description of continuity, and are found chiefly in the bark, though not confined to it, as they are to be met with also both in the alburnum and matured wood, as well as in the fibres of herbaceous plants. But they are particularly conspicuous in the stem and other parts of the different species of euphorbia and periploca; and in all plants, in general, containing thick and resinous juices, known by the name of the proper juices, to the ready passage of which their great width of diameter is well adapted. Sometimes they are distinguishable by their color, which is that of the juices contained in them, being white as in euphorbia; or yellow, as in celandine; or scarlet as in piscidia erythrina. In this plant they are united in bundles, but are detachable from one another by means of being steeped for a few days in spirit of turpentine, when they become altogether colorless and transparent, because the resinous matter which they contained has been dissolved. Senebier says they retain their cylindrical form even in their detached state; and if so, the membrane of which they are composed must be very strong. The porous tubes resemble the simple tubes in their general aspect; but differ from them in being pierced with small holes, or pores, which are often distributed in regular and parallel rows. They are found in most abundance in woody plants, and particularly in wood that is firm and compact, like that of the oak; but they do not, like the simple tubes, seem destined to contain any oily or resinous juice.

149. The *spiral vessels* are fine transparent and thread-like substances, occasionally interspersed with other tubes of the plant; but distinguished from them by being twisted from right to left, or from left to right, in the form of a cork-screw. They occur in most abundance in herbaceous plants, particularly in aquatics; but they are also to be met with in woody plants, whether shrubs or trees. If the stalk of a plant of the liliaceous tribe, or a tender shoot of the elder, is taken and partly cut across, and then gently broken or twisted asunder, the spiral tubes may be seen with the naked eye, uncoiled somewhat, but remaining still entire, even after all the other parts have given way; and, if the inferior portion of the stalk is not very large, it may be kept suspended for some considerable time merely by the strength of the tubes, which though now almost entirely uncoiled, by means of the weight they support, will, when they finally break, suddenly wind up at each extremity, and again resume their spiral form.

150. Grew and Malpighi, who first discovered and described them, represented them as resembling in their appearance the trachea, or windpipe of animals, and designated them by the same term; an appellation by which they are still very generally known. Du Hamel endeavoured to convey an idea of their form, by comparing it to that of a piece of riband rolled round a small cylinder, and then gently pulled off in the direction of its longitudinal axis. The figure of the riband becomes thus loosely spiral. This is a very good illustration of the figure of the spiral tubes in their uncoiled state, but it does not represent them very correctly as they exist in the plant. But the best illustration of this kind is perhaps that of Dr. Thomson's. Take a small cylinder of wood, and wrap round it a piece of fine and slender wire, so as that the successive rings may touch one another, and then pull out the cylinder. The wire, as it now stands, will represent the spiral tubes as they exist in the plant. And if it is stretched, by pulling out the two extremities, it will represent them in their uncoiled state also. But, although the spiral tubes are to be met with in almost all plants, they are not yet to be met with in all the different organs of the plant; or, at least, there are organs in which they occur but rarely, or in very small numbers.

They do not seem to occur often in the root, or at least they are not easily detected in it.

Grew and Malpighi, do indeed, represent them as occurring often in the root, the former refering for examples to the roots of plants in general, and the latter to those of the asparagus, poplar, convolvulus, elm tree, and reed; all of which, Keith says, 'I have examined with great care, without being able to discover any spiral tubes. Senebier says he found them in the root of the balsams and thorn-apple; in examining which I was equally unsuccessful as in examining the former. I cannot, however, doubt the accuracy of the observations of the above phytologists, and can only set down my own want of success in discovery to the score of some defect, either in the specimens examined, or in my mode of examination. Indeed, the only root in which I have ever found them, after examining a very considerable number, is that of the common garden lettuce, know by the name of cos lettuce. Having taken the root of a plant that was just putting out its flowers, and stripped it of its bark, I then cut it partly across, about the middle of its length, and broke the remainder of it gently asunder. On examining the surface of the fracture with the microscope, fragments of spiral tubes were seen projecting from it near the centre. They did not seem very tenacious of their spiral form; and when once uncoiled did not readily resume it.'

151. The spiral threads are to be found also in the stem and branch; but not in all parts of them; or at least not in all periods of their growth. It seems very doubtful, whether they exist at all in the bark. Daubenton professes, indeed, to have seen them in it; but no one else ever has; so that we are, perhaps, sufficiently well warranted in entertaining our doubts. It seems also very doubtful, whether they exist in that part of the stem which consists of matured wood, though Daubenton professes to have seen them in the wood of cedrela; in which case he does not altogether stand alone; as they are represented both by Grew and Hedwig, as visible also in the wood. But they have not been found in the matured wood by any other vegetable anatomists. Du Hamel never met with them in any of the woody parts of woody plants, except in the young and herbaceous branches. Mirbel expresses himself to the same effect. And Mr. Knight, who has examined the subject perhaps still more recently, could not detect them in any of the permanent parts of such plants, except in the annual shoot. Keith's observations on this subject have had nearly a similar result. Among many subjects of examination he mentions only the elder, willow, hawthorn, cherry, and elm tree. In the three former, he found them only in the annual shoot, situated immediately without the pith, or rather imbedded in the alburnum; though in the elder some of them seemed to be imbedded even in the pith itself. In the cherry he found also a very few, similarly situated, in the branch of two years old; but none in wood older than that. And in the elm tree he has thought he had discovered them even in the matured wood. Having placed under the microscope a very thin slice, taken from a piece of the trunk of an elm tree, that had been felled at least six or seven years, he thought he was able to trace the remains of the spiral tubes. The slice was taken from the surface of a longitudinal section passing through the centre of the trunk, and clear of divergent layers; and the tubes seemed to appear most distinct when the slice was so placed as to present their longitudinal dimensions to the light. They seem to resemble ribands wrapped spirally round a cylinder, rather than to form separate vessels, which corresponds very well to their appearance, even in the succulent parts of many plants, as described by Knight. Some of them seemed even separate and entire. And yet, upon repeated observation, he has not been able to satisfy himself entirely on this point; but he has stated the case circumstantially, as being the probable means of inducing some one to take up the subject, who may be more felicitous in his investigations. It cannot be said to be a vain or fruitless enquiry. For as they are known to have existed at least in the tender shoot, it will follow that they must exist, in one shape or other, in the matured wood also. And if their spiral form is there obliterated, under what other aspect do they now appear? It seems certain, from the observations of Hedwig, that they assume a different figure in different stages of the plant's growth. In the peduncle of the colchicum autumnale, the rings of the tubes are closer when it begins to appear above ground, than at the time of flowering, from which he concludes, that they are at length entirely obliterated, and the tubes converted into woody fibre. But sometimes it is difficult to detect them, even in the young shoot; though they are generally to be observed by breaking it gently asunder, and then examining the surface of the fracture with a microscope. In this case they appear in small fragments, projecting from the surface, and somewhat uncoiled; but if the shoot is split longitudinally, a portion of them will sometimes be found extended longitudinally on the surface of the fissure in an uncoiled state.

152. In the stem and branches of herbaceous plants, they are generally discoverable, without much difficulty, accompanying the longitudinal fibres, and forming part of the bundles. Keith has found them in the stem and branches of the burdock, even in winter, when the fragments of the mature plant had become quite indurated by means of their exposure to the weather.

153. They are also very easily detected in the foot-stalk, both of the leaf and flower, accompanying, or rather seeming almost entirely to compose, the bundles of longitudinal fibres. This may be well exemplified in the leaf-stalk of the artichoke, when young and fresh, in the fibres of which they are not only remarkably large and distinct, but also remarkably beautiful; some of them exhibiting in their natural position the appearance of spiral coats, investing interior fibres, rather than that of forming a distinct tube, and seeming when uncoiled to be themselves formed of a sort of net-like membrane.

154. They are discoverable also in the leaf, though not quite so easily detected as in the leaf-stalk. But if a leaf is taken and gently torn asunder in a transverse direction, fragments of the spiral tubes will be seen projecting from the

torn edges, and generally accompanying the nerves.

155. They are also to be found both in the calyx and corolla, but not so generally as in the leaf, on which account some botanists have decided rather too hastily with regard to their non-existence in these parts of the flower. Mirbel says, no tracheæ are to be found in the calyx nor in the corolla, except in the claw. But Keith has found them most unequivocally in the calyx of scabiosa arvensis; and also in the expansion of the corolla of the same plant, as also in the calyx, both proper and common, of dipsacus sylvestris, and in the corolla of the honey-suckle, in which they appear to be placed within the nerves, or at least to be closely united to them.

156. In the other parts they do not seem to occur frequently, or at least it is difficult to detect them. Malpighi represents them, indeed, as occurring in the stamens, but Keith was not fortunate enough to meet with them in the stamens of any flower he examined. He looked for them also in the style of many flowers, and found them in that of the honey-suckle only.

157. According to the observations of Grew and Malpighi, they are to be met with both in fruits and seeds; though Hedwig says, they are not to be seen in the cotyledons, except during the process of germination, and that only by means of their being moistened with some colored infusion. But Gærtner says, they are conspicuous in the thinner cotyledons, even before germination takes place; and Reishel is said to have detected them even in the plumelet and radicle.

158. But, in whatever part of the plant they are found to exist, they are always endowed with a considerable degree of elasticity, as has been already noticed. For though they are forcibly extended, so as wholly to undo the spires, they will again contract, and resume their former figure, when the extending cause is withdrawn; and if they are even stretched till they break, the fragments will again coil themselves up as before. It has been said, however, that those of the butomus umbellatus, if once uncoiled, will contract again no more. But this is true only when they are stretched to a great length. For when they are stretched gently and moderately, they will again contract, as has been proved by experiment.

159. Malpighi, in the course of some observations on the spiral tubes during the winter season, fancied he had perceived a sort of vermicular and spontaneous movement in them. But he thought he saw this movement only once, and as it has never since been seen by any subsequent observer, it appears that we must be content to set it down to the score of microscopical deception, or to the effect of the atmosphere upon the tubes when exposed to its action.

160. We have now run over the differences of the most important kind, by which the functions of what Darwin not inaptly called the viviparous system of vegetation, are affected. Let us now proceed to consider the nature and destination of the oviparous system, or of the parts of reproduction by seed. As the former depend upon internal organisation, so do the latter upon external peculiarities.

161. Hitherto we have scarcely spoken of the flower; that brilliant ornament of plants, which attracts admiration by the splendor of its colors, and the delicacy of its texture, by the delicious perfume which it exhales, and by the wonderful mechanism with which it is constructed. Its base, which acts as an external envelope, is ordinarily of a green color, and is called the calyx. The next envelope, which is the most striking, as it is in it that the beauty of the flower resides, is the corolla. Then succeed the stamens, which are generally delicate threads, terminated by a dilatation of a particular nature; and the pistillum, consisting of ovarium and stigma, which in time becomes the fruit. These parts generally exist all in a single flower, which is then termed complete; if a part of the members is absent, the flower is termed incomplete. Each organ is susceptible of an infinite variety of combinations and modifications in form, in number, in station, in proportion, or in structure, which give rise to the smaller divisions of vegetables called genera. These will be noticed hereafter. The functions only of the organs are to occupy our attention while treating of Vegetable Physiology.

162. The most easy to observe is the corolla; which is composed of one or more pieces called petals; in the former state it is monopetalous, in the latter polypetalous. The petals are either equal or unequal in their form or insertion, whence corollas are either regular or irregular.

163. The stamens appear, from their position, to bear a direct relation with the corolla; thus, in almost all monopetalous flowers, they originate from the corolla itself; but in polypetalous flowers this more rarely happens; then, however, they maintain so many relations with the petals, being alternate or opposite to them, and equal or double or multiple in number, that it is impossible to doubt of the strict alliance by which they are connected. The calyx has a yet more strict analogy with the corolla, the divisions of which are almost always equal in number to those of the calyx, and alternate in insertion, especially when the corolla arises immediately from the calyx. It often happens that it arises from a particular place which is called the receptacle. These three parts, then, have a great analogy with each other; so that one does not vary in the number of its divisions, without affecting the two others by the change. They are themselves, however, subordinate to the pistillum.

*163. There is generally only one pistillum in flowers; occasionally two or more: but these variations in number are independent of the other organs. The ovarium has then a more obvious relation: it is seated in the centre of the flower, at the bottom of the calyx, to which it is attached by its base; sometimes a cohesion takes place between the sides of the calyx and ovarium, which latter then appears to support the flower like a footstalk. From these two modifications arise those two important distinctions among plants, of ovarium superius, or separate from the calyx, and ovarium inferius, or adhering to the calyx; differences which are of extreme importance in

characterising many of the most natural of the systematic combinations of modern botanists.

164. In some flowers the corolla disappears, or is not developed, in others the calyx seem to be wanting. Touching this fact, has arisen a disquisition, which seems to have no end, as to what name ought to be applied to the envelope of a flower when one envelope only is present. By whatever name this single envelope may be called, it bears the same relation to the other parts as the calyx and corolla when both are present; it is in some cases itself almost obliterated, and there are some flowers which consist only of stamens without corolla, and which are then called naked.

165. When both calyx and corolla exist together or one of them only, another set of organs occasionally disappears, namely the stamens, and then the pistillum is found alone in the centre; but in this case it always happens, that, either upon the same plant or upon a different individual, flowers exist which contain stamens only, and no pistillum. Sometimes both organs are developed without covering, and separate from each other. However these two parts may be separated from each other, they always appear at the same period of time, and, ever since the study of plants has been an object of philosophical research, no instance has been found of a perfect plant in which both organs did not co-exist.

166. It appears therefore, from this example, and from many others which could be brought forward, that the stamens and the pistil are the only essential parts of a flower; a fact which is not surprising as far as the pistil is concerned, because we have seen that it contains the rudiments of the future progeny. But what manner of influence is exercised by the stamens? If we examine them in every flower within our reach, we shall find that they have a similar structure: we shall see that they consist of two parts, the upper resembling a little bag, generally yellow, and always divided into one or two cells, which contain a kind of powder, and the lower resembling a thread-like stalk to the former. The former is called the anther, and the latter the filament. The powder which it contains, examined through a microscope, consists of granules, varying in size and form according to their species, and sometimes so remarkably, that it is often possible to distinguish genera by the inspection of the granules only. Thrown into water they swell, and eventually burst, emitting a peculiar fluid which resembles vapor. The name given to the granules is pollen.

167. From the combination of these observations, we come to an important discovery; we perceive that the petals, with the brilliant tints of every color of the rainbow, are in fact the curtains of the nuptial bed of Flora, within the protection of which the mysteries of generation are accomplished. We have, therefore, sexes in plants; these, indeed, appear almost indispensable. In most animals they are separated; but in vermes we see them confounded, and at length disappear entirely. The want of the power of motion in vegetables renders their union in one individual of great importance. But, as if the resources of nature were illimitable, they are in some cases separated upon the same tree, or upon different trees, and the agency of the wind or of insects, is requisite to enable them to accomplish their destiny.

168. The relation, therefore, of the stamens to the pistillum, gives rise to some further considerations. When they are united in one flower, the flower in that case is called hermaphrodite; if they are in separate flowers, it is declinous; it is monœcious when the male and female are present in different flowers of the same individual; diœcious, if in flowers of different individuals. Some plants have male and female flowers mixed with such as are hermaphrodites; then they are called polygamous.

14. The pistillum offers a multitude of most important characters. Its ovary is terminated by one or several styles, and each of the latter has one or more stigmata. The ovarium either contains only one rudiment of a seed, called an ovulum, or several, and is divided internally into one cell or many.

170. The fruit, which is the necessary consequence of the ovarium, is generally like it in the number of its parts; the occasional abortion of some one of the latter, is the only way in which the number of parts is smaller in the fruit than in the ovarium. The form, the texture, and the volume of fruit give rise to an infinity of differences. Thus one sees, on the one hand, soft pulpy fruit, and, on the other hand, nuts, the shell of which is hard as wood itself. The manner in which the seeds are attached is also subject to variation, for they either proceed from a central receptacle, or from the paries of the fruit. The point from which they proceed is, in all cases, called the placenta. This organ is of great importance; for it is not only the medium through which the fecundating effluvia of the pollen is communicated to the ovula, but also through which the juices are elaborated, which are required for the development of the embryo. It may be compared to the placenta of animals.

· 171. The position of the embryo, with relation to the fruit, is also a point of importance. Thus the axis of the seed may be parallel with the axis of the fruit, and fixed by the basis, which is the most natural position; then the seed is called erect. It may become horizontal; or being affixed to the summit of the cell it may become inverted; it is in the latter case said to be pendulous. For various modifications of the position of the seed, see SEED, under PURE BOTANY.

172. Each seed may be considered as an isolated individual; for nature has prepared them for separation from their parent without inconvenience. Their interior consists of a substance of various degrees of texture, which is called the albumen, and of the fleshy body already mentioned as the seminal embryo. The albumen may be absent, the embryo must be present. The coat of the seed consists of two layers, the interior of which is much more membranous than the exterior.

· 173. But now arises a problem in vegetation which it is very important to resolve. Whence is the origin of the flower? Linnæus has offered an explanation, which he considered capable of of meeting every difficulty, and which he bor-

rowed from Cæsalpinus, whose knowledge ran far beyond that of his age. According to these two authors the flower is only a manifestation of the interior of a plant. The epidermis and cuticle give rise to the calyx, the fibre to the corolla, the woody fibre to the stamen, and the pith to the pistillum; this last part is the most essential, and the centre of vegetation; the others are only accessory.

174. But this ingenious notion, like many other brilliant hypotheses, will not bear a strict scrutiny. The nature of the pith is now better understood, and instead of being a creating organ, it is itself, in fact, a body in a state of disorganisation. A single fact has overthrown the whole theory: this is the more intimate knowledge of the interior of palms, and other monocotyledonous trees. According to the arrangement of their interior, and the mixture of the pith and woody fibre, it would happen, if Linnæus's theory were true, that the flowers of the palm would have quite another arrangement from that of other plants, and that the parts would neither be arranged round a centre, nor be placed in the same relation to each other.

175. It appears certain, that, notwithstanding the striking differences which all parts of a flower exhibit, they have all the same origin; which is indicated by the propensity they all have, under certain circumstances, of changing into each other from circumference to centre, or of reverting to one common appearance; which is that of the leaf. Upon this subject Mr. Lindley remarks, 'that it is well understood that the universal principle upon which perfect vegetables are formed, is by the continual addition of parts one above the other, round a common axis, which is produced by their accretion. This law is not confined to the production of foliage, or branches only, but must be considered to extend to the ultimate point of vegetable development in the ovarium; and seems to indicate that the progress of nature is continually onwards. Unless, therefore, it should be shown that the order of alteration in the structure of organs so produced is in monstrous formations reversed, it would be a reasonable inference that nature follows her usual course in transformation, as well as in original production; and that the changes which particular portions of a flower may undergo, always have the character of that series which is placed next them in the inside, and not of that on the outside. The consequence of the prevalence of such a law would therefore be this, with respect to the formation of double flowers, that bracteæ, if present, would change into calyx, calyx into petals, petals into stamens, and stamens into ovaries; and that the reverse of that order could not take place.'

176. It may thence be concluded that a flower is a leaf-bud in a particular state of alteration; that the calycine lobes, the petals, the stamens, the pistillum, are all leaves in an altered form, and that they have all a tendency, which may now and then manifest itself, of assuming their primitive habit and structure. Whence they arise, or in what way this extraordinary metamorphosis takes place, we are as yet unable to determine.

177. The pistillum, which is the terminating point of the line of vegetation, is now ascertained to be, not, as was formerly supposed, an anomalous organ, which was referable to none of the simple types upon which the other parts of fructification are modelled, but a leaf or leaves also in a state of greater affinity to their type than any other organ. The style is an alteration of the middle nerve, the stigma a secreting surface proceeding from the tip of the same part, the sides of the ovarium the two halves of the leaf, and the placenta the edges of the leaf. This is tolerably obvious in a strictly simple unilocular ovarium, such as one segment of a Pæony fruit. But in a many-celled pistil it is not so apparent. Mr. Robert Brown, however, has demonstrated, that all multilocular compound ovaria are merely an aggregation of a number of simple ovaria round a common axis; that the cells are occasioned by the interposition and cohesion of the sides of simple ovaria, which in that state are called dissepiments.

178. Besides the plants which are furnished with a flower, there are others in which no apparent flowers exist, which are constructed differently from either monocotyledonous or dicotyledonous plants, and whose methods of reproduction are quite of another nature. These plants are called cryptogamous, and consist of ferns, mosses, hepaticæ, lichens, algæ, and fungi. They are all supposed to be destitute of cotyledons, whence they are also named acotyledonous.

179. In ferns, which are by some authors referred to monocotyledons, the mode of growth resembles in some measure such plants. The grain from which they are reproduced, and which is called a sporule, in germination dilates into a very small leaf of a particular kind, which successively gives rise to others, which finally acquire the stature and the form of adult leaves. A species of trunk or stipes, similar to that of the palm, creeps along the surface of the earth, or elevates itself above it. Its internal structure separates it as far from monocotyledons as from dicotyledons. It has, however, at the first sight, the greatest resemblance to the former; a section of it offers, as in monocotyledons, certain scattered points, among a mass of parenchyma. These points, which vary in almost every different species, are a section of a peculiar substance, which is divided at the base, and united at the summit, and which may be compared in texture to the liber of dicotyledons. It is surrounded by a fur, which is more or less apparent, and more or less deeply colored, and which seems analogous to the woody texture, especially as in arborescent ferns it is it which forms the solid substance. Both these substances are distributed among the nerves of the leaves, which are simple, ramified, or verticillated, according to the species. In the opinion of a celebrated modern physiologist, a fern may be considered as a plant turned inside out.

180. The remaining classes of cryptogamia consist entirely of cellular tissue, amassed in different proportions, and under various forms. They are destitute of woody vessels or of tracheæ, and have no distinction between bark, wood, and epidermis; they may perhaps be considered

to consist wholly of the latter and former confounded.

IV.—PURE BOTANY.

181. We have thus considered botany with respect to its analogies, its history, and its physiology. It now remains for us to explain its practical details, as applied to what is called Systematic Botany, or the science of arranging the natural objects of which it consists.

182. The materials of this branch of the science are the modifications of parts; from a just application of these materials result classifications. We shall first attend to modifications.

183. All perfect plants consist, as has been already seen, of the following organs. 1. The Root; 2. the Stem; 3. the Foliage; 4. the Inflorescence; 5. the Flower; 6. the Fruit. Each of these organs must be considered separately. But, before entering upon an explanation of the peculiarities of each of them, it will be proper to notice the terms used in speaking of their size, surface, and color; these terms being applicable to each of the six parts into which a plant is divisible.

184. There are eleven terms which are employed to designate the size or measurement of a plant or its parts, viz.:

1. A hair breadth (capillus), the measure of a hair, or the twelfth part of a line.
2. A line (linea), the length of the white crescent at the root of the nail of the middle finger, or the twelfth part of an inch.
3. A nail length (unguis), the length of the nail of the middle finger, or half an inch.
4. An inch (pollex, uncia), the length of the first joint of the thumb, the twelfth part of a foot.
5. A hand breadth (palmus), the breadth of the four fingers of the hand, or three inches.
6. A span (dodrans), as far as one can span with the thumb and the little finger, or nine inches.
7. A small span (spithama), as far as one can span with the thumb and fore finger, or seven inches.
8. A foot (pes), the length from the elbow to the wrist, or twelve inches.
9. A cubit (cubitus), from the elbow to the point of the middle finger, or seventeen inches.
10. An ell (ulna, brachium), the length of the whole arm, or four and twenty inches.
11. A fathom or toise (orgya), the length of the arms stretched out from the tip of one middle finger to that of the other, or six feet.

For these the following have been substituted by some French botanists:—

The millimètre = $\frac{441}{1000}$ of a line.
The centimètre = 4 lines $\frac{432}{1000}$.
The decimètre = 3 inches 8 lines $\frac{320}{1000}$.
The mètre = 3 feet 11 lines $\frac{296}{1000}$.

185. The surface of plants is of great importance in distinguishing the species and varieties of plants, but is not of value in generic discrimination. The terms which follow are, or ought to be, used precisely in the sense here ascribed to them; they are extremely well defined by Willdenow, who limits them thus:

1. Shining (nitidus), when the surface is so smooth that it reflects the rays of light, and has a shining or glancing appearance, as in the leaves of the holly, Ilex aquifolium.
2. Dull (opacus), when the surface does not reflect the rays, and is entirely void of lustre.
3. Even (lævis), without striæ, furrows, or raised dots. It is the opposite of Nos. 6, 7, 23, 24, 25, 28, and 29.
4. Smooth (glaber), when there are no visible hairs, bristles or thorns. It is the opposite of Nos. 8, 22, 26 and 27.
5. Dotted (punctatus), where small fine dots are perceived by the eye but not by the touch. Thymus vulgaris.
6. Scabrous (scaber), where small raised dots are felt but not seen; as in Carex acuta.
7. Rough (asper), when these dots are both felt and seen. Pulmonaria officinalis.
8. Hispid (hispidus), beset with very short stiff hairs. Myosotis arvensis.
9. Hirsute (hirtus), where the hairs are moderately long but very stiff. Echium vulgare.
10. Hairy (pilosus), beset with long single hairs, somewhat bent. Hieracium pilosella.
11. Villous (villosus), where the hairs are long, soft, and white. Stachys Germanica.
12. Pubescent (pubescens), overgrown with short fine white hairs. Oenothera mollissima.
13. Silky (sericeus), when the surface is white and shining, by means of thick and almost invisible hairs. Potentilla anserina.
14. Woolly (lanatus), when the surface is beset with long thick white hairs, easily distinguished. Stachys lanata.
15. Tomentose (tomentosus), when fine hairs are so matted together that the particular hairs cannot be distinguished. In this case the surface generally appears white, as in Verbascum; or of a rust color, as in Ledum.
16. Bearded (barbatus), when the hairs are in tufts. Mesembryanthemum barbatum.
17. Strigose (strigosus), when the surface is armed with small, close-lying bristles, which are thickest below. Lithospermum officinale.
18. Stinging (urens), when a painful burning sensation is caused by small hairs. Urtica. Such hairs are called stimuli.
19. Fringed (ciliatus), when on the margin of a leaf, or the surface of a stalk, there is a row of hairs of equal length.
20. Warty (papillosus), when small fleshy warts appear. Aloe margaritifera.
21. Pustular (papulosus), when there are small hollow bladders. Mesembryanthemum hispidum.
22. Muricated (muricatus), armed with small short herbaceous spines. Asperugo procumbens.
23. Scaly (lepidotus), when the surface is covered with small scales closely placed, by which means the color is changed, as in Elæagnus angustifolia.
24. Mealy (farinosus), when the surface is thickly covered with a white powder, as in Primula farinosa.
25. Hoary (pruinosus), when the surface is strewed with a very fine white dust, like the fruit of some plumbs. Prunus domestica.
26. Glutinous (glutinosus), when the surface is covered with an adhesive matter, which is soluble in water. Primula glutinosa.

27. Viscid (viscidus), when the surface is covered with a viscid juice, which is resinous or greasy. Cerastium viscosum.

28. Striated (striatus), when the surface is finely streaked. Aira caespitosa.

29. Furrowed (sulcatus), when the streaks form small furrows. Umbellæ.

186. The following are the principal *colors*, which are distinguished by name: this part of the subject is extremely imperfect; and perhaps from its nature will always, like all distinctions depending upon so uncertain a power as that of discriminating between the delicate gradations o so unmanageable an agent as of light, remain in an imperfect state. The Latin names are necessarily employed from the want of equivalent expressions in the English language

1. Cyaneus; dark blue, like Prussian blue.
2. Cæruleus; sky blue, like the flowers of Veronica Chamædrys.
3. Azureus; nearly the same as No. 2, but bright like ultramarine.
4. Cæsius; pale blue, verging towards gray.
5. Atrovirens; dark green, bordering upon dark blue.
6. Æruginosus; light bluish green, like verdigris.
7. Prasinus, saturatè virens, smaragdinus; grass green, without any tinge of yellow or blue.
8. Flavo-virens; green bordering upon yellow.
9. Glaucus; green, bordering upon gray.
10. Aureus; golden yellow, without any foreign mixture.
11. Ochraceus; yellow, with a slight tinge of brown.
12. Pallidè flavens; pale or whitish yellow.
13. Sulphureus; bright yellow, like the flowers of the Hieracium Pilosella.
14. Vitellinus; yellow, with a slight tinge of red.
15. Ferrugineus; brown, verging towards yellow.
16. Brunneus; the darkest pure brown.
17. Fuscus; brown, running into gray.
18. Badius; Hepaticus; chestnut or liver brown, bordering on dark red.
19. Aurantiacus; orange, or a mixture of yellow and red.
20. Miniatus, or Cinnabarinus; deep red, like red lead.
21. Lateritius; brick color, like the former, but duller and verging towards yellow.
22. Coccineus, or Phœniceus; cinnabar color, with a slight tinge of blue.
23. Carneus; flesh color, something between white and red.
24. Croceus; saffron color, dark orange.
25. Puniceus; fine bright red, like carmine.
26. Sanguineus, or purpureus; pure red, but duller than the foregoing.
27. Roseus; rose color, a pale blood red.
28. Atropurpureus; very dark red, almost approaching to black.
29. Violaceus; violet color, a mixture of blue and red.
30. Lilacinus; lilac, the former color; but duller, and verging towards red.
31. Ater; the purest and deepest black.
32. Niger; black, with a tinge of gray.
33. Cinereus; ash color, blackish gray.
34. Griseus; lively light gray.
35. Canus; hoary, with more white than gray.
36. Lividus; dark gray, running into violet.
37. Lacteus, or Candidus; shining white.
38. Albus; dull white.
39. Albidus; dirty dull white.
40. Hyalinus; transparent, like pure glass.

187. The Root is divided by botanists into four principal forms, viz. the *Rhizoma*, or Roststock, by which is meant the thick fleshy part of a biennial or perennial root; the *Fibre*, or those parts of the root which have the appearance of threads; the *Tuber*, which is a solid fleshy root, furnished with buds on its surface, and being in fact a thickened subterraneous stem; and the *Bulb*, which consists only of fleshy imbricated scales, as in the onion. Each of these is subject to a great variety of appearances.

1. *The Rhizoma is,*

1. Woody (lignosum), composed of a woody substance and numerous woody fibres; such as that of trees and shrubs.
2. Fleshy (carnosum), consisting of a fleshy substance more or less firm; as Daucus Carota, Pastinaca Sativa.
3. Hollow (cavum), that is always hollow in the middle, as Fumaria Bulbosa.
4. Partitioned (loculosum), an oblong root, internally furnished with separated cavities; as Cicuta Virosa.
5. Entire (integrum), never naturally internally hollow, and thus the opposite of the two last mentioned.
6. Cylindrical (cylindraceum), that comes nearest to a cylindrical figure, and is thick; as Dictamnus albus.
7. Spindle-shaped (fusiforme) cylindrical above, and tapering to a point as it descends; as in Daucus carota, Pastinaca sativa.
8. Bitten (præmorsum), where the principal root seems as if it were bitten off, as Scabiosa succisa, Plantago major.
9. Worm-like (vermicularis), thick and almost cylindrical, but bent in different places; Polygonum Bistorta.
10. Turnip shaped (napiforme), bellying out above, but below ending in a long taper point, Brassica Napa.
11. Roundish (subrotundum, or globosum), that is almost spherical, as Raphanus sativus, Bunium Bulbocastanum.
12. Flat (placentiforme), a thick round root, which above and below is compressed, so that it almost resembles a plate; Cyclamen.
13. Jointed (geniculatum), divided into members, from which the root-fibres proceed; Gratiola officinalis.
14. Scaly (squamosum), covered with more or fewer fleshy scales; Lathræa squamaria.
15. Toothed (dentatus), a fleshy branched root, having teeth-like prolongations; Corallorhiza innata.
16. Tufted (comosum), having as it were tufts of hair at its points, which are the fragments of the petioles, divided like fibres; Aethusa Meum.
17. Many headed (multiceps), divided at top

into numerous branches, from which new shoots spring; as Astragalus, Geranium macrorhizon.

18. Simple (simplex), having no branches.

19. Branching (ramosum), dividing into branches, as all trees, shrubs, and many plants.

20. Perpendicular (perpendicularis), going straight down into the earth; Capsella bursa pastoris.

21. Horizontal (horizontale), running horizontally under ground into the earth, but obliquely, as Aethusa meum.

22. Oblique (obliquum), going neither perpendicularly nor horizontally into the earth, but obliquely; as Aethusa meum.

23. Creeping (repens), lying horizontally under the earth, and extending itself in that direction by means of side-branches; as Rumex Acetosella.

24. Ringed (annulatum), furnished on its upper surface with alternately raised and depressed bands.

25. Knobbed (tuberculatum), furnished on its upper surface, with protuberances; as Aethusa meum, Bunium bulbocastanum.

26. Scarred (cicatrisatum), which, upon the perishing of the stem, has depressions or chinks on its upper surface; as Polypodium vulgare.

27. Chaffy (paleaceum), covered with membranaceous scales; as many of the filices.

28. Even (laeve), marked on its surface neither with elevations nor depressions.

2. *The Fibre is,*

29. Thread-like (filiformis), consisting of a single fibre.

30. Fibrous (fibrosa), consisting of many fibrous roots; as Poa annua.

31. Hair-like (capillaris), consisting of numerous very fine fibres; as Scirpus acicularis.

32. Velvet-like (velutina), composed of very tender and hardly visble fibres; as in the Musci frondosi.

33. Cleft (fissa), very short, and at the point dividing into two or three points; Peltidea canina.

3. *The Tuber, is*

34. Knobbed (granulatum), the knobs formed like small grains of corn; as Saxifraga granulata.

35. Testiculated (testiculatum), when two, rarely three, longish depressed knobs hang from the point from which a shoot rises; as in Orchis.

36. Palmated (palmatum), when two, rarely three, longish depressed knobs, which are divided at the point, hang together; as in the last, Orchis.

37. Fingered (digitatum), when a single fleshy knob is compressed and divided at the point like fingers; Dioscorea alternifolia.

38. Bundled (fasciculatum), when many cylindrical or longish roots hang together from the point, so as to resemble a bundle; Ranunculus Ficaria, Epipactis Nidus avis.

39. Globulated (conglobatum), when several round knobs sit upon one another; as Helianthus tuberosus.

40. Depending (pendulum), when several knobs hang together from fibrous roots; as Solanum tuberosum, Spiræa Filipendula.

41. Articulated (articulatum), when one knob grows out of another, so that the whole seems to consist of connected members.

42. Necklace-like (moniliforme), when many knobs hang together by a fibrous root, in rows as if they were strung on; as Pelargonium triste.

4. *The Bulb is,*

43. Imbricated (imbricatus, squamosus), when the bulb consists of leaves lying over one another, like the tiles of a house; as Lilium bulbiferum.

44. Coated (tunicatus), when the bulb is composed of concentric layers; as in Allium.

45. Net-like, (reticulatus), when the bulb is entirely composed of reticulated membranes; as Allium Victorialis.

46. Half-net-like (semireticulatus), when the bulb consists of a firm mass, but the outer membrane is net-like; as Gladiolus communis.

47. Solid (solidus), when the bulk consists of a firm substance throughout; as Colchicum autumnale.

48. Nestling (nidulans), when small bulbs appear under the external membrane, and the bulb seems to be entirely composed of them; as in Ornithogalum spathaceum.

49. Aggregated (compositus, aggregatus), when several bulbs stand close together, having a connexion at the base.

50. Two-fold (geminatus), when two bulbs are connected by their base; as Fritillaria pyrenaica, Erythronium dens canis.

51. Doubled (duplicatus), when one bulb stands above another, and grows out of it; as Allium sphaerocephalon.

52. Supported (suffultus), when the body of the root stands at a distance, equalling it in size, and distinctly separated from it; as Ixia punicea, erecta.

53. Single (solitarius), when neither from the side nor from the base proceeds another bulb.

54. Central (centralis), when the shoot proceeds from the middle, as Galanthus nivalis.

55. Lateral (lateralis), when the shoot issues from the side; as in Ixia virgata.

Besides the above there are a few roots which being referable to none of the foregoing, are called nothous, or

Anomalous.

56. Divided (divisa), that branches out above stones or other bodies, but does not penetrate into the earth; as Fucus digitatus.

57. Bysus-like (byssacea), that is divided like wool, and has the appearance of a filamentary byssus; as many species of Agaricus.

58. Warty (papillosa), consisting of short wart-like small dots, by which the plant attaches itself to wood or stones, in Lichen.

59. Shield-like (scutiformis), when the base of the ascending stem spreads itself into a thin surface, by which the plant is attached to wood or stones; as Usnea florida, Ceramium filum.

60. Fading (evanescens), when the descending stem penetrates into wood and therein gradually disappears; as Viscum album.

188. The Stem is the prolongation of the plant above the soil, or above the part which serves for its support. It is subject to great

diversity of forms, and the number of terms used to distinguish their varieties are numerous.

The stock (cormus), is that part of the plant which serves for the support of the whole, and bears the inflorescence, the leaves, the frond, the flowers and fruit, from it are evolved in most cases all these parts. The following kinds have been distinguished: viz. the stem (caudex), the trunk (truncus), the stalk (caulis), the straw (culmus), the scape (scapus), the stipe (stipes), the shoot (surculus), the sarment (sarmentum), and the sucker (stolo).

189. The stem (caudex), is a simple perennial shoot, with leaves at its extremity, and is peculiar only to the palms and arboreous filices, having no bark, but set round with the remains of the leaf-stalks. Of this there are the following kinds.

1. Ringed (annulatus), when the remains of the leaves at regular distances resemble annular elevations; as Corypha rotundifolia.

2. Scaly (squamosus), when the remains of the leaves surround the stem irregularly; as in Phœnix dactylifera, Chamærops humilis.

3. Tessellated (tessellatus), when the leaf or the base of the stipe does not remain behind, but leaves a scar, by which the stem puts on a tessellated appearance; as Polypodium arboreum.

4. Aculeated (aculeatus), when the remains of the leaf are set with prickles; as in Cocos aculeatus, Polypodium asperum.

5. Smooth (inermis), the opposite of the last, when the remains of the leaf leave no prickles, as Phœnix dactylifera, Polypodium arboreum.

190. The trunk (truncus), is peculiar to trees and shrubs, and is perennial. The principal stem in these plants has obtained the following denominations: its principal divisions are called branches (rami), and its subdivisions twigs (ramuli).

1. Tree-like (arboreus); this is simple, and forms at top a crowd or crown of branches (cacumen); it is peculiar to trees.

2. Shrubby (fruticosus), divided below into a number of branches, like all shrubs.

191. The stalk (caulis), is herbaceous, seldom woody, and lasts but one or two years; hence it is proper only to herbaceous plants, however, the term is sometimes applied both to trees and shrubs. The divisions of this are also called branches (rami). The kinds are,

With respect to division.

1. Very simple (simplicissimus), that has no branches, nor is its flower-stalk divided, consequently it can have but one flower or spike, and no flowers in the axillæ of the branches.

2. Simple (simplex), having no branches, but whose flower-stalk may be divided.

3. Somewhat branched (subramosus), sometimes without branches, sometimes with one or two.

4. Branched (ramosus), which is always furnished with branches.

5. Much branched (ramosissimus), where all the branches are not only divided but subdivided.

6. Disappearing (deliquescens), branched, but so divided that the principal stem is no longer to be observed, but is lost in the ramification.

7. Entire (integer), which is branched, but where the principal stem can be traced to the point.

8. Verticillated (verticillatus), when a number of branches are formed at the extremity, from the centre of which the principal stem proceeds, so that the branches, at certain distances, surround the stem in a circular manner; as in Pinus sylvestris.

9. Proliferous (prolifer), where the stem is divided into a number of branches, and these again likewise divide, but the principal stem does not proceed from the centre of them; as Ledum palustre.

10. Dichotomous (dichotomus), when the stem, even to the smallest branches, divides itself into two; as Viscum album.

In respect of the branches.

11. Alternate branches (rami alterni), the branches are so placed that between two on the one side there rises but one on the opposite side.

12. Opposite branches (rami oppositi), when one branch stands on the opposite side to another, and the bases of each nearly meet together.

13. Distichous (distichus), when the branches, being opposite to each other, stand on the same plane.

14. Scattered (sparsus), when the branches stand without order on the stem.

15. Close (confertus), when the branches stand so thick and without order that no space remains between them.

16. Brachiate (brachiatus) when opposite branches stand at right angles to each other, or cross-ways.

17. Rod-like (virgatus), when the branches are very long, weak, and thin.

18. Panicled (paniculatus), when a stem at its point is divided into numerous leaves and flower-bearing branches; as, Rumex acetosella.

19. Fastigiate (fastigiatus), when all the branches from bottom to top are of such different lengths that they are of equal height.

20 Compact (coarctatus), where the tips of the branches are bent inwards towards the stem.

21. Spreading (patens), when the branches stand nearly at right angles with the stem.

22. Diverging (divergens), where the branches form a right angle.

23. Divaricated (divaricatus), where the branches are so situated that they form an obtuse angle above, and an acute angle below.

24. Deflected (deflexus), the branches hang down forming an arch.

25. Reflected (reflexus), where the branches hang so much down that they almost run parallel with the stem.

26. Retroflected (retroflexus), where the branches are bent towards every side.

In respect of strength.

27. Stiff (rigidus), that will not bend without breaking.

28. Brittle (fragilis), that breaks with the smallest force.

29. Flexible (flexilis), that can be bent in any direction without breaking.

30. Tough (tenax) that can be bent without breaking, and can be with difficulty torn.

31. Lax (laxus), that is firm, but moves with the smallest breath of wind.

32. Parasitical (parasiticus), that fixes itself by its root on the root or wood of other plants; as Viscum, Monotropa.

33. Erect (erectus), when the stem stands nearly perpendicular.

34. Straight (strictus), where the stem is perpendicular, and quite straight.

35. Weak (debilis), when the stem is too slender to maintain itself perfectly upright.

36. Bent upwards (adscendens), when the stem lies on the ground, but the extremity of it stands erect.

37. Bent downwards (declinatus), when the stem is so bent downwards to the earth that it forms an arch.

38. Supported (fulcratus), that from above sends roots down into the earth, which afterwards change into real stems; as in the Rhizophora.

39. Stooping (cernuus), when the point in an upright stem takes a horizontal direction.

40. Nodding (nutans), when the point is bent down towards the horizon.

41. Pendulous (pendulus), when a parasitical plant (No. 32) has its base turned towards the zenith, and its top towards the earth.

42. Procumbent (procumbens, prostratus, humifusus), when the stem lies flat on the ground.

43. Decumbent (decumbens), when the stem is upright below, but above is bent down towards the ground, so that the greater part of it is bent.

44. Creeping (repens), when the stem lies along, and sends out roots from below.

45. Sarmentose (sarmentosus), when the stem lies along, but sends out roots only at certain intervals.

46. Rooting (radicans), when the stem stands upright and climbs, everywhere sending forth small roots, by which it holds itself fast; as in the ivy. Hedera Helix.

47. Swimming (natans), lying on the surface of water; as Polygonum amphibium.

48. Sunk (demersum), that lies below the surface; as Ceratophyllum demersum, Utricularia.

49. Flexuose (flexuosus), where the upright stem bends itself in a zig-zag manner, so as to form a number of obtuse angles.

50, Climbing (scandens), a weak stem that fastens itself to some other body for support; as the passion-flower, Passiflora cærulea.

51. Twining (volubilis), a weak stem that twines in a serpentine form round other plants; it is of two kinds.

a. Turning from the right (dextrorsum), when the stem twines from the right to the left round a supporting body; as in the bind-weed, Convolvulus.

b. Twining from the left (sinistrorsum), when the stem twines from the left to the right round a supporting body; as in the hop, Humulus Lupulus.

In respect of clothing.

52. Naked (nudus), having no leaves, scales, or the like.

53. Leafless (aphyllous), without leaves only.

54. Scaly (squamosus), covered with scales.

55. Ramentaceous (ramentaceus), that is covered with dry membranous scales; as Erica ramentacea.

56. Stipulate (stipulatus), furnished with stipulæ in the axillæ of the leaves; as Vicia sativa.

57. Exstipulate (exstipulatus), without stipulæ.

58 Leafy (foliosus), having leaves.

59. Perfoliate (perfoliatus), where the stem goes through a leaf; as Bupleurum.

60. Winged (alatus), when a leaf-like membrane runs along the stem.

61. Bulb-bearing (bulbifer), having bulbs or tubercles in the axillæ of the leaves; as Lilium bulbiferum, Dentaria bulbifera.

62. Prickly (aculeatus), when along the stem there are pointed protuberances coming off with the rind.

63. Spiny (spinosus), when there are pointed protuberances on the stem which do not come off with the rind

64. Smooth (inermis), having neither prickles nor spines.

65. Barren (sterilis), bearing no flowers.

66. Fruitful (fructificans), bearing flowers or fruit.

In respect of figure.

67. Round (teres), that is, quite cylindrical.

68. Half-round (semiteres), that is, round on the one side and flat on the other.

69. Compressed (compressus), when the stem is flat on both sides.

70. Two-edged (anceps), when a compressed stem is sharp on both edges.

71. Angled (angulatus), when a stem has several angles, but the sides are grooved. Of this there are several kinds, viz.

α. Obtuse-angled (obtuse angulatus).

β. Acute-angled (acute angulatus).

γ. Three-angled (triangularis).

δ. Four-angled (quadrangularis, &c.)

ε. Many-angled (multangularis).

72. Three-sided, (triqueter), where there are three sharp corners, and the sides quite flat.

73. Three-cornered (trigonus), when there are three round or obtuse edges, but the sides appear flat. Of this too there are several kinds :

α. Four-cornered (tetragonus).

β. Five-cornered (pentagonus).

γ. Six-cornered (hexagonus).

δ. Many-cornered (polygonus).

74. Membranaceous (membranaceus), when the stem is compressed and thin like a leaf.

75. Knotted (nodosus), when the stem is divided by knobs.

76. Knotless (enodis), when it has neither knobs nor joints.

77. Articulated (articulatus), when the stem has regular knobs at the joints ; as in Cactus.

78. Jointed (geniculatus), when a stem has regular knobs, not seated on the joints.

In respect of substance.

79. Woody (lignosus), that consists of firm wood.

80. Fibrous (fibrosus), that consists of woody fibres, that can be easily separated.

81. Herbaceous (herbaceus), that is weak and can be easily cut.

82. Fleshy (carnosus), that is nearly as juicy and soft as the flesh of an apple.

83. Firm (solidus), internally hard.

84. Empty (inanis), filled internally with a soft pith.

85. Hollow (fistulosus), without any pith within and quite hollow.

86. With separations (septatus), where either the pith or the hollow space is divided by thin partitions.

87. Cork-like (suberosus), when the outer rind is soft and spungy: as in the ulmis suberosa.

88. Rifted (rimosus), when there are in the rind thin clefts or chinks.

89. Scarred (cicatrizatus), having scars formed by the falling off of the leaves.

192. The straw (culmus) is proper only to the grasses. The kinds of it are nearly the same with those of the stem. The following, however, may be distinguished in addition.

1. Knotted (nodosus), furnished with enlarged joints, as most of the grasses.

2. Knotless (enodis), without any such enlarged joints. Juncus, Carex, Scirpus.

3. Simple (simplex), having no branches.

4. Branched (ramosus), furnished with branches.

5. Leafy (frondosus), furnished with irregular branches, and particularly with small leaves; as Restio.

6. Sheathed (vaginatus), that is covered with a foliaceous vagina.

7. Naked (nudus), having neither a foliaceous vagina nor any leaves.

8. Erect (erectus), standing quite upright.

9. Geniculated (geniculatus or infractus), when the first and undermost joint lies prostrate, and the rest stand upright, so that by this flexure nearly a right angle is formed; as in Alopecurus geniculatus.

10. Oblique (obliquus), having such a direction as to be intermediate between perpendicular and horizontal; as Poa annua.

193. The scape (scapus) is an herbaceous stem that bears flowers, but not leaves, and proceeds from the descending, or intermediate, but never from the ascending stem.

It is proper to the lilies, and is sometimes found in other plants; but in this last case it ought to bear more than one flower, for had it but one flower it would be called pedunculus radicalis. It is only when this single flower sits on a flower-stalk proceeding immediately from the ground that it is called scape.

194. The stipe (stipes). This term is applied only to Filices, Fungi, and Palms. The following are the kinds of it.

In Filices.

1. Chaffy (paleaceous), when it is covered with dry membranaceous scales.

2. Scaly (squamosus), when it is covered with foliaceous scales.

3. Naked (nudus), without any covering.

4. Prickly (aculeatus), having prickles.

5. Smooth (inermis), without prickles.

In Fungi.

6. Fleshy (carnosus), of a fleshy substance.

7. Leathery (coriaceous), consisting of a tough leather-like substance, as boletus perennis.

8. Firm (solidus), consisting within of a solid mass.

9, Hollow (fistulosus), forming throughout a hollow cylinder.

10. Pitted (lacunosus), having depressions on the outside; as Helvella sulcata.

11. Scaly (squamosus), covered with firmly attached scales.

12. Squarrose (squarrosus), covered with scales which are turned back at the points.

13. Raised (peronatus), that from the bottom to the middle is laid thick over, with a woolly substance ending in a sort of meal.

14. Bellying (ventricosus), thicker in the middle than at either end.

15. Bulb-like (bulbosus), that is thick immediately above the root.

195. The shoot (surculus), is a term applied to the stem which bears the leaves of the mosses. Of this there are the following varieties.

1. Simple (simplex), having no branches; as in the Polytrichum commune.

2. Branched (ramosus), dividing into branches; as in Mnium androgynum.

3. With hanging branches (ramis deflexis), when the stem is branched but all the branches hang down; as in Sphagnum palustre.

4. Irregular (vagus), branched, but the branches set on without order.

5. Intricate (intricatus), branched, and the numerous protuberant branches running into one another.

6. Tree-like (dendroides), standing erect, and at the point a crowd of thick branches like the top of a tree.

7. Pinnated (pinnatus) having at two opposite sides simple branches, of nearly the same length, at equal angles with the stalk.

8. Doubly pinnated (bipinnatus), having the habit of the last, only that its branches are again divided like those of the principal stem; as Hypnum parietinum.

9. Trebly-pinnated (triplicatio pinnatus), like the last, but the secondary branches are also pinnated; as Hypnum recognitum.

10. Proliferous (prolifer), when, in either of the two last kinds, there shoots forth a new stem out of the old; as in Hypnum proliferum.

11. Erect (erectus), which rises perpendicularly; as in Polytrichem commune.

12. Prostrate (procumbens), lying along.

13. Creeping (repens), the same with the last, but the branches constantly lengthening and putting forth small roots.

14. Floating (fluitans), swimming under water in a perpendicular direction, and attached to some fixed body; as Fontinalis antipyretica.

196. The sarment or runner (sarmentum), is a filiform stem, springing from the root and shooting from the point, so sending forth roots and producing a new plant of the same kind; as Saxifraga sarmentosa, Fragaria.

197. The sucker (stolo), is a foliaceous creeping stem, springing from the root, covered on its under surface with small roots, but at the point

bearing a number of leaves from which comes a new plant; as Ajuga reptans, Hieracium pilosella.

198. The Foliage consists of the leaves, and their several parts, with the tendrils or other appendages connected therewith. The leaves are the organs in which the juices of the plant are elaborated, and rendered fit for being returned into the system, through the descending vessels of the bark, and the radiating vessels of the wood. They begin where the primordial scales at the base of the plant, if any, terminate; and they cease to be considered leaves as soon as the inflorescence (inflorescentia) commences; if situated among the inflorescence they are denominated bracteæ.

199. The leaf is divided into three distinct parts: the *stipulæ*, the *petiole*, the *laminæ*.

200. The *stipulæ* are minute scale-like appendages, seated at the base of the common or partial petiole; occasionally they are foliaceous; their position is liable to slight variation, being sometimes at the base of the petiole, sometimes adnate with its margin, and occasionally placed on the side of the stem opposite to the petiole. The stipulæ are to the leaf, what the bracteæ are to the flowers.

201. The *petiole* is the foot-stalk of the leaf, and is subject to nearly the same variations in form as the stem; the terms applied to which are equally applicable to the petiole.

202. The *lamina* is a term used to express the leaf itself, considered without reference to the petiole or stipulæ.

Leaves are said to be simple when they consist of one lamina only; and to be compound, when they are formed by the union of more laminæ than one. The following are the terms employed in speaking of leaves.

A. Simple Leaves.

In respect of the apex.

A leaf is said to be:

1. Acute (acutum), when the leaf ends in a point.
2. Acuminated (acuminatum), when the point is lengthened out.
3. Pointed (cuspidatum), when the lengthened-out point ends in a small bristle.
4. Obtuse (obtusum), when the end of the leaf is blunt or round.
5. Mucronate (mucronatum), when there is a bristle-shaped aculeus, situated on the round end of a leaf; as in the Amaranthus blitum.
6. Bitten (præmorsum), when the leaf is as it were bitten off at the point, forming a curved line; as in the Pavonia præmorsa.
7. Truncated (truncatum), when the point of the leaf is cut across by a straight line; as in the Liriodendron tulipifera.
8. Wedge-shaped (cuneiforme), when a truncated leaf is pointed on both sides at the base.
9. Dedaleous (dædaleum), when the point has a large circuit, but is truncated and ragged.
10. Emarginated (emarginatum), when an obtuse pointed leaf has a part as it were taken out of the apex.
11. Retuse (retusum), when an obtuse leaf is somewhat emarginated, but in a small degree.
12. Cleft (fissum), when there is a cleft at the point, extending half way down the leaf. When there is but one cleft at the point, the leaf is called bifid (folium bifidum); if there are two clefts, it is called trifid (trifidum); if there are more clefts, the leaf is called quadrifidum, quinquefidum, &c. multifidum, with many clefts.
13. Fan-shaped (flabelliforme), when a truncated cuneiform leaf is at the point once or oftener cleft.
14. Tridentated (tridentatum), when the point is truncated, and has three indentations.

In respect of the base.

15. Heart-shaped (cordatum), when the base is divided into two round lobes, the anterior part of the leaf being ovate.
16. Kidney-shaped (reniforme), when the base is divided into two round separate lobes, and the anterior part of the leaf is round.
17. Moon-shaped (lunatum), when both lobes at the base have either a straight or somewhat arched line, and the anterior part of the leaf is round.
18. Unequal (inæquale), when one side of the leaf is more produced than the other.
19. Arrow-shaped (sagittatum), when the base is divided into two projected pointed lobes, and the anterior part of the leaf is likewise pointed.
20. Spear-shaped (hastatum), when the two pointed lobes of the base are bent outwards.
21. Ear-shaped (auriculatum), when there are at the base two small round lobes bent outwards. It is nearly the hastate leaf, only the lobes are smaller and round.

In respect of circumference.

22. Orbicular (orbiculatum), when the diameter of the leaf on all sides is equal.
23. Roundish (subrotundum), differs little from the foregoing, only that the diameter is longer, either from the base to the apex, or from side to side.
24. Ovate (ovatum), a leaf which is longer than it is broad; the base is round and broadest, the apex narrowest.
25. Oval or elliptical (ovale or ellipticum) a leaf whose length is greater than its breadth, but round both at base and apex.
26. Oblong (oblongum), when the breadth to the length is as one to three, or the breadth always least; but the apex and base vary, that is, they are sometimes obtuse, sometimes pointed.
27. Parabolic (parabolicum), a leaf is so called which is round at the base, then forms a small bend, and grows less towards the point.
28. Spatulate (spatulatum), when the fore part of a leaf is circular, growing smaller toward the base, as in the cucubalus otites.
29. Rhombic (rhombeum), when the sides of the leaf run out into an angle, so that the leaf represents a square.
30. Oblique (subdimidiatum), is that leaf which has one side broader than the other.

Of this leaf there are several varieties: as

a. Heart-shaped oblique (sub-dimidiatio-cor-

datum) a heart-shaped leaf, which is at the same time oblique, as in the Begonia nitida.

b. Trapeziform (trapeziforme), a rhombic leaf, with one side smaller than the other, &c.

31. Panduræform (panduræforme), when an oblong leaf has a deep curve on both sides.

32. Sword-shaped (ensiforme), an oblong leaf, growing gradually narrower towards the apex, which is pointed, the sides are flat, and have more or less of an arch-like form; as in the sword flag, Iris.

33. Lanceolate (lanceolatum), an oblong leaf which grows gradually narrower from the base to the point.

34. Linear (lineare), when both sides of a leaf run parallel to each other, so that it is equally broad at the base and the apex.

35. Capillary (capillare), when a leaf has scarcely any breadth, and is as fine as a thread or hair.

36. Awl-shaped (subulatum), a linear leaf, which is sharply pointed.

37. Needle-shaped (acerosum), a linear leaf that is rigid, and generally endures through the winter; as in the pine tribe, Pinus.

38. Triangular (triangulare), when the circumference represents a triangle, the apex of which makes the point of the leaf; as in the birch, Betula alba.

39. Quadrangular, quinquangular (quadrangulare, quinquangulare), when the circumference of the leaf has four or five angles; as in the Menispermum Canadense.

40. Intire (integrum, indivisum), which is not at all cleft or divided.

41. Lobed (lobatum), when a leaf is deeply divided, nearly half its length, into lobes. According to the number of lobes it is denominated bi-lobed (bi-lobum), as in Bauhinia; tri-lobed (tri-lobum), quinquelobed (quinquelobum), as in the hop, Humulus lupulus, &c.

42. Palmated (palmatum), when there are five or seven very long lobes, that is, when the segments are more than half way divided.

43. Divided (partitum), when in a roundish leaf the division extends to the base; Ranunculus aquatilis.

44. Two-ranked (dichotomum), the last leaf, whose linear sections are divided or subdivided into twos.

45. Torn (laciniatum), when an oblong leaf has several irregular clefts.

46. Sinuated (sinuatum), when on the sides of an oblong leaf there are round incisures, as in the oak, Quercus robur.

47. Pinnatifid (pinnatifidum), when there are regular incisures, to go almost to the middle rib.

48. Lyre-shaped (lyratum), nearly the foregoing leaf, whose outer segment is very large and round.

49. Runcinate (runcinatum), when the incisures of a pinnatifid leaf are pointed, and form a curve behind, as in the dandelion, Leontodon taraxacum.

50. Squarroso-laciniate (squarroso-laciniatum), when the leaf is cut almost into the middle rib, and the incisures run in every direction; as in the thistle, Carduus lanceolatus. N. the contour of the leaves from No. 41 to 43 is round. From 44 to 49 it is oblong.

In respect of the margin.

51. Quite entire (integerrimum), when the margin is without either notch or indentation. N. this, No. 50 and No. 40, are often confounded. An entire leaf is merely the opposite of the numbers from 40 and 41 to 49. It may often be either dentated or serrated. A quite entire leaf may, indeed, be formed like numbers from 41 to 47, but it can have no indentations or serratures, as in the following leaves:

52. Cartilagineous (cartilagineum), when the margin consists of a border of a harder substance than the disk.

53. Undulated (undulatum), when the margin is alternately bent in and out.

54. Crenated (crenatum), when the margin is set with small and round notches, having at the same time a perpendicular position.

55. Repand (repandum), when there are on the margin small sinuses, and between them segments of a small circle.

56. Toothed (dentatum), when the margin is set round with small pointed and distinctly separated teeth.

57. Duplicato-dentate (duplicato-dentatum), when each small tooth of the margin is again dentated; as in the elm, Ulmus campestris.

58. Dentato-crenate (dentato-crenatum), when each tooth is set with small and round denticuli.

59. Serrated (serratum), when the teeth on the margin are very sharp pointed, and stand so close that one seems to lie on the back of another.

60. Gnawed (erosum), when the margin is unequally sinuated, as if it had been gnawed; as in some species of sage, Salvia.

61. Spiny (spinosum), when the margin is set with spines; as in the thistle, Carduus.

62. Fringed (ciliatum), when the margin is set round with strong hairs, of equal length, and at a considerable distance from one another.

In respect of their surface.

63. Aculeated (aculeatum), when the surface is covered with spines.

64. Hollow (concavum), when there is a hollow in the middle of the leaf.

65. Channelled (canaliculatum), when the middle rib of a long and narrow leaf is furrowed.

66. Wrinkled (rugosum), when the surface is raised between the veins of the leaf, and thus forms wrinkles; as in sage, Salvia.

67. Bullate (bullatum), when the parts raised between the veins on the surface appear like blisters.

68. Pitted (lacunosum), when the raised places between the veins are on the under surface, so that the upper surface appears pitted.

69. Curled (crispum), when the leaf is fuller on the margin than in the middle, so that it must lie in regular folds.

70. Folded (plicatum), when the leaf lies in regular straight folds from the base.

71. Veined (venosum), when the vessels of a leaf rise out of the middle rib. This is the case in most plants.

72. Netwise-veined (reticulato-venosum), when the veins which rise from the middle rib again subdivide into branches, that form a sort of net-work.

73. Ribbed (costatum), when the veins arise out of the middle, and proceed in a straight line towards the margin in considerable numbers, and close together; as in the Calophyllum inophyllum, Canna, Musa, &c.

74. Nerved (nervosum), when the vessels rising out of the petiolus run from the base to the apex.

75. Three-nerved (trinervium), when three nerves take their origin from the base. Thus we likewise say, quinquenervium, septemnervium, &c.

76. Triple-nerved (triplinervium), when out of the side of the middle rib, above the base, there arises a nerve running towards the point; as in Laurus, Cinnamomum, and Camphora.

77. Quintuple-nerved (quintuplinervium), when out of the middle rib, above the base, there arise on each side two nerves running towards the point.

78. Septuple-nerved (septuplinervium), when on each side of the middle rib, above the base, three nerves arise, and proceed to the apex.

79. Venose-nerved (venoso-nervosum), when, in a leaf having nerves, the vessels run into branches, or in a veined leaf; as in the Indian cress, Tropæolum majus.

80. Streaked (lineatum), when the whole leaf is full of smooth parallel vessels, that run from the base to the apex.

81. Nerveless (enervium), when no nerves rise from the base.

82. Veinless (avenium), where there are no veins.

83. Dotted (punctatum), when, instead of ribs and veins, there are dots or points; as in the Vaccinium vitis idaea.

84. Colored (coloratum), a leaf of some other color than green.

85. Cowled (cucullatum), when in a heart-shaped leaf the lobes are bent towards each other, so as to have the appearance of a cowl.

86. Convex (convexum), when the middle of the leaf is thicker than the rim, raised on the upper surface and hollowed on the under.

87. Keel-shaped (carinatum), when on the under surface of a linear-lanceolate, or oblong leaf, the place of the middle rib is formed like the keel of a ship.

88. Quadruply-keeled (quadricarinatum), when the middle rib, by means of a thin leaf above and below, projects, and the margin is incrassated, so that a horizontal section has the appearance of a cross; as Ixia cruciata.

B. Compound Leaves.

89. Compound (compositum), when several leaves are supported by one foot-stalk. To this term belong Nos. 89, 92, 95, 96, 97. But when the leaf agrees with the above definition, although it should not come under any of the following kinds, it is still to be considered a compound leaf.

90. Fingered (digitatum) when the base of several leaves rests on the point of one foot-stalk; as in the horse-chestnut, Aesculus Hippocastanum.

91. Binate (binatum), when two leaves stand by their base on the top of one foot-stalk; but if the two foliola of a binate leaf bend back in a horizontal direction, it is called a conjugate leaf, folium conjugatum.

92. Bigeminate (bigeminatum, bigeminum), when a divided leaf-stalk at each point bears two leaves; as in some species of Mimosa.

93. Trigeminate (trigeminatum or tergeminum), when a divided leaf-stalk on each point bears two leaves, and on the principal stalk, where it divides, there is a leaf at each side; as in the Mimosa tergemina.

94. Ternate (ternatum), when three leaves are supported by one foot-stalk; as in the clover, Trifolium pratense. Strawberry, fragaria vesca.

95. Biternate (biternatum, or duplicato-ternatum), when a foot-stalk, which separates into three, at each point bears three leaves.

96. Triternate (triternatum, or triplicato-ternatum), when a foot-stalk, which separates into three, is again divide at each point into three, and on each of these nine points bears three leaves.

97. Quadrinate (quadrinatum), when four leaves stand on the point of a leaf-stalk; as Hedysarum tetraphylium.

98. Quinate (quinatum), when five leaves are supported by one foot-stalk: this, it is true, has some affinity with No. 89, but varies on account of the number five, as in the other there are generally more leaves.

99. Umbellate (umbellatum), when at the point of a leaf-stalk there stand a number of leaves, closely set, and forming the figure of a parasol; as Aralia sciodaphyllum, Panax chrysophyllum.

100. Pedate (pedatum, ramosum), when a leaf-stalk is divided, and in the middle, where it divides, there is a leafet, at both ends there is likewise a leafet, and on each side, between the one in the middle and that at the end, another or two, or even three leaves. Such a leaf therefore consists of five, seven, or nine leafets, that are all inserted on one side; as in the Helleborus viridis, fœtidus, and niger.

101. Pinnated (pinnatum), where on an undivided leaf-stalk there is a series of leafets on each side, and on the same plane; of this there are the following kinds: α. Abruptly-pinnated (pari pinnatum, or abrupte pinnatum), when at the apex of a pinnated leaf there is no leafet.

β. Pinnate with an odd one (impari-pinnatum, or pinnatum cum impari), when at the apex of a pinnated leaf there is a leafet.

γ. Oppositely pinnate (opposite pinnatum), when the leafets on a pinnated leaf stand opposite to one another.

δ. Alternately pinnate (alternatim pinnatum), when the leafets on a pinnated leaf stand alternately.

ε. Interruptedly pinnate (interrupte pinnatum), when in a pinnated leaf each pair of alternate leafets is smaller.

ζ. Jointedly pinnate (articulate pinnatum), when between each pair of opposite pinnæ, or leafets, the stem is furnished with a jointed edge.

η. Decursively pinnate (decursive pinnatum), when from each particular pinnula a foliaceous appendage runs down to the following one.

ϑ. Decreasingly pinnate (pinnatum foliolis decrescentibus), when the successive foliola on a pinnated leaf grow gradually smaller to the point; as in the Vicia sepium

102. Conjugately pinnated (conjugato-pin-

natum), when a leaf-stalk divides, and each part makes a pinnated leaf.

103. Ternato-pinnate (ternato-pinnatum) when at the point of a principal leaf-stalk there stand three pinnated leaves; as Hoffmanseggia.

104. Digitato-pinnate (digitato-pinnatum), when several simply pinnated leaves, from four to five, stand on the point of one stalk; as in Mimosa pudica.

105. Doubly pinnate (bipinnatum, duplicato-pinnatum), when a leaf-stalk bears, on one plane on both sides, a number of leaf-stalks, of which each is a pinnated leaf.

106. Trebly pinnate (triplicato-pinnatum, or tripinnatum), when several doubly pinnated leaves are attached to the sides of a foot-stalk on one plane.

107. Doubly compound (decompositum) when a divided leaf-stalk connects several leaves; of this kind are Nos. 90, 91, 93, 98, 99, 100. But the term decompositum is only used when the division of the leaf-stalk of the pinnulæ is irregular.

108. Super-decompound (supra-decompositum), when a leaf-stalk, which is often divided, sustains several leaves; to this belong Nos. 94, 101. But then the term is used only when the divisions of the leafets are either more numerous or not so regular.

C. In respect of the place.

109. Radical (radicale), when a leaf springs from the root, as in the violet, Viola odorata. Sagittaria sagittifolia.

110. Seminal (seminale), when a leaf grows out of the parts of the seed, as in the hemp; where, as soon as it springs, there appear two white bodies, which are the two halves of the seed that change into leaves.

111. Cauline (caulinum), which is attached to the principal stem. The root leaves and stem leaves of a plant are often very different

112. Rameous (rameum), when a leaf rises from the branches.

113. Axillary (axillare or subalare), which stands at the origin of the branch.

114. Floral (florale), which stands close by the flower.

D. In respect of substance.

115. Membranaceous (membranaceum), when both membranes of a leaf lie close upon one another, without any pulpy substance between them; as in the leaves of most trees and plants.

116. Fleshy (carnosum), when between the membranes there is much soft and pulpy substance; as in houseleek, Sempervivum tectorum.

117. Hollow (tubulosum), when a somewhat fleshy and long leaf, as in the onion, Allium Cepa.

118. Bilocular (biloculare), when in a linear leaf, internally hollow, the cavity is divided by a longitudinal partition into two. Lobelia dortmanna.

119. Articulate (articulatum, or loculosum), when a cylindrical hollow leaf has its cavities divided by horizontal partitions; as Juncus articulatus.

120. Cylindrical (teres), when it is formed like a cylinder.

121. Compressed (compressum), when a thick leaf is flat on both sides.

122. Two-edged (anceps), when a compressed leaf is sharp on both edges.

123. Depressed (depressum), when the upper surface of a fleshy leaf is pressed down, or, as it were, hollowed out.

124 Flat (planum), when the upper surface of a thick leaf forms an even plane.

125. Gibbous (gibbosum, or gibbum), when both surfaces are convex.

126. Scimitar-shaped (acinaciforme); a two-edged thick leaf, on one side sharp and arched, on the other straight and broad.

127. Axe-shaped (dolabriforme), when a fleshy leaf is compressed, circular on the upper part, convex on the one side, sharp edged on the other, and cylindrical at the base.

128. Tongue-shaped (linguiforme), when a long compressed leaf ends in a round point.

129. Three-sided (triquetrum), when the leaf is bounded by three narrow sides, and is at the same time long.

130. Deltoid (deltoideum), when a thick leaf is bounded by three broad surfaces, and is at the same time short.

131. Four-cornered (tetragonum), when a leaf, long in proportion, is bounded by four narrow surfaces; as in the Pinus nigra.

132. Warty (verrucosum), when short fleshy leaves are truncated, and stand in thick heaps; as in some Euphorbiæ.

133. Hook-shaped (uncinatum), when a fleshy leaf is flat above, compressed at the sides, and bent back at the point.

E. In respect of situation and position.

134. Opposite (folia opposita), when the bases of the leaves are next each other, on opposite sides of a stem.

135. Dissimilar (disparia), when of two leaves, placed opposite, the one is quite differently formed from the other; as some species of Melastoma.

136. Alternate (alterna), see No. 11.

137. Scattered (sparsa), when the leaves stand thick on the stem, without any order.

138. Crowded (conferta, or approximata), when the leaves stand so close together that the stem cannot be seen.

139. Remote (remota), when the leaves are separated on the stem by certain interstices.

140. Three-together (terna), when three leaves stand round the stem: there are sometimes four, five, six, seven, eight, &c., quaterna, quina, sena, septena, octona, &c.

141. Star-like (stellata, or verticillata), when several leaves stand round the stem at certain distances; as in ladies-bedstraw, Galium, &c.

142. Tufted (fasciculata), when a number of leaves stand on one point; as in the larch, Pinus larix, Celastrus buxifolius.

143. Two-rowed (disticha), when leaves are so placed on the stem that they stand on one plane; as in the pitch fir, Pinus picea, Lonicera symphoricarpus.

144. Decussated (decussata), when the stem, in its whole length, is set round with four rows of leaves at each branch, and when one looks perpendicularly down upon it, the leaves seem to form a cross; as in Veronica decussata.

145. Imbricated (imbricata), when one leaf lies over another, as the tiles upon a roof. Of this there are the following kinds:

a. Bifariously imbricated (bifariam imbricata), when the leaves are so laid upon one another that they form but two rows longitudinally on the stem.

β. Trifariam imbricata, three rows.

γ. Quadrifariam imbricata, &c. four rows, &c.

F. In respect of insertion.

146. Petiolated (petiolatum), when a leaf is furnished with a foot-stalk.

147. Palaceous (palaceum), when the foot-stalk is attached to the margin.

148. Peltated (peltatum), when the foot-stalk is inserted into the middle of the leaf.

149. Sessile (sessile), when the leaf is attached to the stem without any foot-stalk.

150. Loose (solutum, or basi solutum), a succulent cylindrical or subulate leaf, which seems to have no connexion with the stalk on which it rests, but seems to hang the more loosely; as Sedum album.

151. Riding (equitans), a sword-shaped or linear leaf, that forms at its base a sharp and deep furrow, whose surfaces lie on one another, and embrace the stalk; Dracaena ensifolia, Sisyrinchium striatum, &c.

152. Decurrent (decurrens), when the foliaceous substance of a sessile leaf runs down along the stem.

153. Embracing (amplexicaule), when a sessile leaf is heart-shaped at the base, and with both lobes embraces the stem.

154. Connate (connatum), when opposite and sessile leaves are joined at their base.

N. A perfoliated leaf (folium perfoliatum), is already described in No. 59.

F. In respect of direction.

155. Appressed (adpressum), when the leaf turns up, and lays its upper surface to the stem.

156. Erect (erectum, or semiverticale), when the leaf is directed upwards, and makes with the stem a very acute angle.

157. Vertical (verticale), which stands quite upright, and thus makes with the horizon a right angle.

158. Bent sideways (adversum), when the margin of a vertical leaf is turned towards the stem.

159. Spreading (patens), which goes off from the stem in an acute angle.

160. Bent in (inflexum, or incurvum), when an upright leaf is bent in at its point towards the stem.

161. Oblique (obliquum), when the base of the leaf stands upwards, and the point is turned towards the ground.

162. Horizontal (horizontale), when the upper surface of the leaf makes with the stem a right angle.

163. Bent down (reclinatum, or reflexum), when the leaf stands with its point bent towards the earth

164. Bent back (revolutum), when the leaf is bent outwards, and its point from the stem.

165. Hanging down (dependens), when the base is turned to the zenith, and the point towards the ground.

166. Rooting (radicans), when the leaf strikes root.

167. Swimming (natans), when the leaf swims on the surface of water; as in Nymphæa alba.

168. Immersed (demersum), when the leaves are found under water.

169. Emerging (emersum), when the leaf of an aquatic plant raises itself out of the water.

203. Besides the petiole, the stipulæ, and the lamina, which have now been described, there are two appendages which properly belong to the foliage, and still remain to be noticed; these are the ramentum, and the cirrhus, or tendril.

204. The rament (ramentum), is a small, often bristle-shaped, leafet, that is oblong, thin, and more or less of a brown color; sometimes placed, like the stipulæ, in the angles of the petiole; but sometimes, likewise, without any order on the stem. It appears on all trees when their buds open, and falls soon after. On the oak it stands like the stipulæ, on the Scotch fir, Pinus sylvestris, it is soon dispersed.

When the stem of a plant is covered with fine dry scales, that have the appearance of the Ramentum, it is properly called a ramentaceous stem, caulis ramentaceus.

205. The tendril (cirrhus), is a filiform body, which serves for attaching plants to some support. It is always an alteration of some other part of the plant; for instance, in the vine, of a leaf, and in the Artabotrys, of a part of the inflorescence. Climbing plants are furnished with tendrils. They are in general spiral. The species are as follows:

1. Axillary (axillaris), when rising from the axillæ of the leaves.
2. Foliar (foliaris), when springing from the points of the leaves.
3. Petiolar (petiolaris), when standing on the point of the common foot-stalk of a compound leaf.
4. Peduncular (peduncularis), when rising from the foot-stalk of a flower.
5. Simple (simplex), when not divided.
6. Convolute (convolutus), when winding regularly round a prop.
7. Revolute (revolutus), when winding irregularly, sometimes to this side, sometimes to that.

206. To the inflorescence are to be referred all those parts which are placed above the articulation, which unites the flower with the plant; strictly speaking, the term denotes the mode in which the flowers are arranged upon their stalk or rachis. We will first describe the different manners in which this is effected, and then explain the nature and modifications of the accessory leaves.

207. The inflorescence in many plants is an important character, and the following kinds have been described, viz.: The whirl (verticillus), the head (capitulum), the ear (spicula), the spike (spica), the raceme (racemus), the fascicle (fasciculus), the umbel (umbella), the cyme (cyma), the corymb (corymbus), the panicle (panicula), the thyrse (thyrsus), the spadix (spadix), and finally, the catkin (amentum).

208. A whirl (verticillus), consists of several flowers that encircle the stem, and stand un-

covered at intervals upon it. Of this there are the following kinds:

1. Sitting (sessilis), when all the flowers sit close to the stem, without foot-stalk, as in the field mint. Mentha arvensis.

2. With a foot-stalk (pedunculatus), when the flowers are furnished with short foot-stalks.

3. Headed (capitatus), when the flowers stand so thick that they take the figure of a half sphere as; Phlomis tuberosa.

4. Half (dimidiatus), when the flowers surround only the half of the stalk; as in balm, Melissa officinalis.

5. Close (confertus), when one whirl stands close above another.

6. Distant (distans), when the whirls stand at a distance one from another.

7. Leafy (foliosus), when there are leaves at the base of the whirl.

8. Leafless (aphyllus), when there are no leaves above the whirl.

9. Bracteate (bracteatus), when there are floral leaves, or bracteæ, at the whirl.

10. Ebracteate (ebracteatus), when there are no bracteæ at the whirl.

11. Naked (nudus), when no leaves or bracteæ stand near the whirl.

12. Six, eight, ten, or many flowered (sex, octo, decem, or multiflorus), when the whirl consists of many flowers.

209. The head (capitulum), is a number of flowers standing thick upon one stalk, so as to form a round head. The flowers have either foot-stalks, or sit close. The following are varieties of this:

1. Spherical (globosum, or sphæricum), when the flowers have a perfectly round form; as in the Gomphrena globosa.

2. Roundish (subglobosum), when the head of flowers is nearly round, but where the length exceeds the breadth; as in clover; Gomphrena globosa.

3. Conical (conicum), when the head is long, drawing towards a point; as in Trifolium montanum.

4. Hemispherical (dimidiatum, or hemisphericum), when the head is round on one side and flat on the other.

5. Leafy (foliosum), when the head is surrounded with leaves.

6. Tufted (comosum), having leaves at the point; as Bromelia ananas.

7. Naked (nudum), when it is devoid of leaves.

8. Standing on the point (terminale), when it stands on the top of the stem.

9. Axillary (axillare), standing on the angles of the leaves, that is, where the base of the leaf, or of the leaf-stalk, is placed.

10. Alar (alaris), sitting on the axillæ of the branches.

210. The ear (spicula or locusta), is either named from the flowers of the grasses enclosed in the glume; or we understand by it also, the flowers of the gramineous plants, such as cyperus, scirpus sylvaticus, &c., which stand closely pressed together on a filiform flower-stalk. It is denominated according to the number of the flowers and their figures.—The following are the kinds of it:—

1. One flowered (uniflora), that contains but one flower; as Agrostis.

2. Two flowered (biflora), having two flowers; as in Aira.

3. Three-flowered (triflora), &c.

4. Many-flowered (multiflora), that contains many flowers.

5. Round (teres), when the flowers in the spicula are so placed that their horizontal section is round; as Glyceria fluitans, &c.

6. Two ranked (disticha), when the flowers in the spicula are placed in two opposite rows on the same level; as in Cyperus.

7. Ovate (ovata), when the outline of the spicula resembles the figure of an egg; as Bromus secalinus.

8. Oblong (oblonga), when the outline of the spicula exhibits an ellipsis more or less perfect.

9. Linear (linearis), when the spicula is long and small, but of equal breadth throughout.

211. The spike (spica) is that sort of inflorescence when many flowers, without any foot-stalk, sit on a simple filiform principal flower-stalk. If there be a foot-stalk, it must be much shorter than the flower. The kinds are,

1. Glomerate (glomerata), when the spike consists of a spherical selection of flowers.

2. Interrupted (interrupta), when the flowers upon the spike are interrupted by naked interstices.

3. Verticillated (verticillata), when the flowers, leaving naked interstices on the spike, appear on that account to be placed in whirls.

4. Imbricated (imbricata), when the flowers stand so thick together that one lies upon another.

5. Distichous (disticha), when the flowers are arranged on the spike in two rows.

6. One-rowed (secunda), when the flowers are all arranged on one side of the spike, so that the other side is naked.

7. Cylindrical (cylindrica), when the spike is equally covered with flowers both above and below.

8. Linear (linearis), that is very slender, and of equal thickness.

9. Ovate (ovata), that is thick above, more slender below, and appears of an oval form.

10. Ventricose (ventricosa), thick in the middle, and slender at both extremities.

11. Leafy (foliosa), having leaves between the flowers.

12. Comose (comosa), having leaves at the apex.

13. Fringed (ciliata), having hairs between the flowers.

14. Simple (simplex), without branches.

15. Branched or compound (ramosa, or composita), when several spikes stand on one branched or divided stalk.

16. Conjugate (conjugata), when two spikes standing on one stalk unite at the base.

17. Bundled (fasciculata), when several spikes standing on one foot-stalk unite at the base.

18. Terminal (terminalis), standing on the apex of the stalk or branch.

19. Axillary (axillaris), standing in the angles at the origin of the leaves.

20. Lateral (lateralis), standing on the wood

of the former year, that is, on the place now destitute of leaves.

212. The Raceme (racemus) is that sort of inflorescence to which several pedunculated flowers are longitudinally attached, nearly of equal length, or at least where the lowest flower-stalks are little longer than the upper. Here follow the different kinds of Raceme ;—

1. One-sided (unilateralis), when only one side of the stem is set with flowers.

2. One-rowed (secundus) when the flower-stalks are situated round the principal stem, but the flowers themselves are directed only to one side.

3. Limber (laxus), when the raceme is very pliant and flexible.

4. Stiff (strictus) when the raceme does not bend.

5. Simple (simplex), when it is unbranched.

6. Compound (compositus), when several single racemes unite on one stem.

7. Conjugate (conjugatus), when two racemes, standing on one stem, unite at the base.

8. Naked (nudus), without leaves or bracteæ.

9. Foliate (foliatus), set with leaves or bracteæ.

10. Bracteate (bracteatus), when there are bracteæ at the flowers.

11. Ebracteate (ebracteatus) having no bracteæ.

12. Erect (erectus), standing upright.

13. Straight (rectus), straight without bending.

14. Cernuous (cernuus), when the apex of the raceme is bent downwards.

15. Nodding (nutans), when the half of the raceme is bent downwards.

16. Hanging (pendulus), when the raceme hangs down perpendicularly.

213. The Fascicle or bundle (fasciculus) is a number of simple foot-stalks, of equal height, which arise at the point of the stem, not from one point, but from several. As an example of the fasciculus may be quoted Dianthus carthusianorum.

214. The umbel (umbella) consists of a number of flower-stalks, of equal length, that rise from the point. In an umbel the flower-stalks are called rays (radii). There are the following varieties of the umbel.

1. Simple (simplex), when the rays bear but one flower.

2. Compound (composita), when each ray of the umbel supports a simple umbel. The rays which support the simple umbels are called the universal or general umbel, umbella universalis. The simple umbels are called the particular or partial umbels, umbella partialis or umbellula.

3. Sitting (sessilis), when the umbel has no stalk.

4. Pedunculated (pedunculata), when it is furnished with a stalk.

5. Close (conferta), when the rays of the umbel stand so near one to another that the whole umbel becomes very thick and close.

6. Distant (rara), when the rays stand wide.

7. Poor (depauperata), when the umbel has but few flowers.

8. Convex (convexa), when the middle rays are high but stand thick, so that the whole form a globular figure.

9. Flat (plana), when the rays being of equal length, the flowers form a flat surface.

215. The cyme (cyma) is that species of inflorescence where the whole at first view has the appearance of a compound umbel, only the principal flower-stalk and those which support the particular florets do not rise from the same point. The flower-stalks rise close above one another and are divided into irregular branches. Examples of the cyme are found in Sambucus nigra, and Viburnum opulus.

216. The corymb (corymbus) is properly speaking an erect racemus, the lower flower-stalks of which are either branched or simple, but always so much produced as to be of equal height with the uppermost.

217. The panicle (panicula) consists of a number of simple flowers that stand on unequally divided branches, and on a long peduncle. The kinds are,

1. Simple (simplex), that has only undivided side branches.

2. Branched (ramosa), when the branches are again branched.

3. Much branched (ramosissima), when the side branches are much divided.

4. Disappearing (deliquescens), when the foot-stalk so loses in branching that it cannot be traced to the end.

5. Spreading (patentissima), when the branches stand wide from one another, and spread out on all sides.

6. Crowded (coarctata), when the branches stand very close together.

7. One-rowed (secunda), when the branches incline all to one side.

218. The Thyrse (thyrsus) is a condensed panicle, whose branches are so thick that the whole has an oval form; as in the flower of the privet, Ligustrum vulgare, Tussilago petasites.

219. The Spadix is peculiar to the palms, and some plants allied to the genus Arum. All flower-stalks that are contained in a vagina, are called Spadix. This organ is sometimes found like a spike, racemus, or panicle, and from these it takes its name.

The terms appropriated to it are the following:

1. Spiked (spicatus), having the appearance of a spike.

2. Raceme-like (racemosus), forming a raceme.

3. Paniculated (paniculata), having the form of a panicle.

220. The Catkin (amentum, or julus,) is a long and always simple stem, which is thickly covered with scales, under which are the flowers, or their essential parts.

Examples of this are found in the willows (salices), hazle (Corylus avellana), hornbeam (carpinus), &c.

1. Cylindrical (cylindricum), which is equally thick above or below.

2. Attenuated (attenuatum), which grows thinner and thinner to the point.

3. Slender (gracile), which is long but has few scales, and also is slender in proportion to its length.

4. Ovate (ovatum) which is thick below and around, but grows gradually more slender to the point.

221. The accessory leaves of the inflorescence

are the bracteæ, of which the spatha, and the involucrum are varieties.

222. The bracteæ are small leaves, placed above the articulation of the inflorescence, near or between the flowers, and in general are of a different shape and color from the other leaves. They are subject to many variations of figure, duration, &c.; the terms to express which are the same as are applied to leaves under similar circumstances.

223. The spatha and the involucrum differ from bracteæ in being situated immediately below the articulation of the inflorescence with the plant. They are both subject to several variations of form, which are designated by particular names.

224. *The spatha is,*

1. Univalve (univalvis) when it consists but of one leaf; as in Arum maculatum.
2. Bivalve (bivalvis) when two leaves stand opposite each other, as in Stratiotes.
3. Halved (dimidiata) when the flowers are covered on one side only.
4. Permanent (persistens) when it remains unchanged till the fruit appears.

225. The involucrum consists of several leaves, surrounding one or several flowers. It is chiefly known in umbelliferous plants, and in compound flowers. In the former the terms employed do not differ from those used for other parts of a plant; in the latter it is altogether of another kind, and requires a particular description.

226. The common calyx, common perianthium, or anthodium, as it is sometimes called, is an involucrum, which contains a great number of flowers, in such a manner as that these flowers appear to form but one; as in the dandelion (Leontodon taraxacum), blue bottle (Centaurea cyanus), sun flower (Helianthus annuus), &c. The kinds are,

1. One leaved (monophyllum), that consists but of one leaf, united at the base, but divided at top.
2. Many leaved (polyphyllum), that is compounded of several leaves.
3. Simple (simplex), when the flowers are surrounded with a single row of leaves.
4. Equal (æquale), when in a simple perianth the leaves are of equal length.
5. Scaly or imbricated (squamosum or imbricatum), when the common perianth consists of closely imbricated foliola.
6. Squamose (squamosum), when the foliola are bent back at the point.
7. Scariose (scariosum), when the foliola are hard and dry; this is found in Centaurea glastifolia.
8. Fringed (ciliatum), when the margins of the foliola are beset with short bristles of equal length.
9. Muricated (muricatum), when the margins of the foliola are set with short stiff prickles.
10. Thorny (spinosum), when each leafet is provided with a thorn: these are either simple thorns (spinæ simplices), or branched (ramosæ).
11. Turbinated (turbinatum), when the perianth has quite the figure of a top.
12. Spherical (globosum), when it has the form of a perfect sphere.
13. Hemispherical (hemisphæricum), when it is round below and flat above.
14. Cylindrical (cylindricum), when the perianth is round and long, as thick above as below.
15. Flat (planum), when the foliola of the perianth are spread out quite flat.
16. Doubled or calyculated (auctum or calyculatum), when at the base of the common perianth there is another row of foliola, that appear to form another involucrum; as in dandelion, Leontodon Taraxacum.

227. The Flower is the part immediately terminating the twigs or branches of the inflorescence, and containing the commencement of the fruit. Its parts are the *Calyx*, the *Corolla*, the *Stamens*, and the *Pistillum;* besides which must be noticed the *Discus*.

228. When the calyx and corolla are so confounded as not to be capable of being distinguished they are called perianthium; as in Butomus.

229. The calyx immediately encloses the flower. It is,

1. Abiding (persistens), remaining after the flower falls off; as in the henbane, Hyoscyamus niger.
2. Deciduous (deciduus), that falls off at the same time with the flower; as in the lime tree, Tilia Europæa.
3. Withering (marcescens), that withers after the flower, but still remains for some time, and at last drops off; as in the apricot, Prunus Armeniaca.
4. Caducous (caducus), that falls off before the flower; as in the poppy, Papaver somniferum.
5. Simple (simplex).
6. Double (duplex), when a double calyx encloses the flower; as the strawberry, Fragaria vesca; mallow, Malva rotundifolia.
7. One leafed (monophyllus), when the calyx consists of one leaf, that is, it may be divided into equal or unequal laciniæ, but all of them are connected at the base.
8. Two, three, four, five-leaved, di-tu-ri-tetra-penta-&c. phyllus, many leaved (polyphyllus), when it consists of two or more foliola.
9. Dentated (dentatus), when it has at the margin short segments or indentations, but which are not deeper at most than the fourth part of the whole calyx. According to the number of these segments the calyx is, bi, tri, quadri, quinque, &c. or multidentatus, with two, three, four, five, or many segments.
10. Cleft (fissus), when the calyx is divided into laciniae, but which reach only to the middle. It is often bi-tri-quadri-multifidus.
11. Parted (partitus), when it is divided down to the base. These divisions are also named according to their number, as bi-tri-quadri-&c. multipartitus.
12. Labiated or bilabiated (labiatus or bilabiatus), when it is deeply divided into two laciniæ, both of which are dentated; as in garden sage, Salvia officinalis.
13. Entire (integer), when a monophyllus ca-

lyx is short, round at the base, and entire on the margin.

14. Urceolated (urceolatus), when a monophyllous calyx is short, round at the base, and entire on the margin.

15. Shut (clausus), when a polyphyllous, or divided calyx, applies itself closely to the corolla.

16. Tubular (tubulosus), when a divided, cleft, or indented calyx, at its origin is cylindrical, and forms a tube.

17. Spreading (patens), when, in a monophyllous or polyphyllous calyx, the foliola or laciniae, stand quite open.

18. Reflected (reflexus), when either the segments, or laciniae in monophyllous calyxes, or the foliola in polyphyllous, are bent back.

19. Inflated (inflatus), when the calyx is hollow, and bellies out.

20. Abbreviated (abbreviatus), when the calyx is much shorter than the corolla.

21. Colored (coloratus), when the calyx is of another color than green.

230. The corolla is the envelope, or small leaves enclosed by the calyx, surrounding the interior parts of the flower, of a more delicate structure than the calyx, and of another color than green. It consists either of one piece or of several; the first called a monopetalous corolla (corolla monopetala), the last polypetalous (corolla polypetala). The pieces it consists of are called petals (petala).

231. The monopetalous corolla is that which consists but of one piece, which, however, may be divided into segments, but which must always be entire at the base. The following are varieties of this corolla:—

1. Tubular (tubulosa), that consists of a single piece, hollow and of equal thickness. The small corolla or floret, which is found included in a common perianthium, is also called tubular, although it sometimes departs from this form.

2. Club-shaped (clavata), which forms a tube, growing gradually wider upwards, and narrower at the aperture.

3. Spherical (globosa), which is narrow above and below, and wide in the middle.

4. Bell-shaped (campanulata), that grows gradually wider to the mouth, so that it has nearly the appearance of a bell.

5. Cup-shaped (cyathiformis), when a cylindrical tube grows gradually wider from below upwards, but the margin is upright, and not bent back or contracted.

6. Urceolated (urceolata), when a short cylindrical tube extends itself into a wide surface, the margin of which is erect.

7. Funnel-shaped (infundibuliformis), when the tube of the corolla grows gradually wide, above that is obversely conical, but the rim pretty flat and turned outwards.

8. Salver-shaped (hypocrateriformis), when the tube of the corolla is perfectly cylindrical, but very long, and the rim forms a broad expansion; as in Phlox.

9. Wheel-shaped (rotata), when a cylindrical tube is very short, nearly shorter than the calyx, sometimes hardly perceptible, and its margin is quite flat. It is almost the same with the foregoing, only the tube is very short; as in shepherd's club, Verbascum.

10. Tongue-shaped (ligulata), when the tube is not long, suddenly ceases, and ends in an oblong expansion; as in the Aristolochia clematitis, and in some flowers that are contained in a common perianthium.

11. Difform (difformis), when the tube gradually becomes wider above, and is divided into unequal lobes; as in some corollas that are included in a common perianthium, e. g. the blue bottle, Centaurea cyanus.

12. Ringent (ringens), when the margin of a tubular corolla is divided into two parts, of which the upper part is arched, the under oblong, and has some resemblance to the open mouth of an animal; as in sage, Salvia officinalis.

13. Masked (personata), when both segments of the ringent flower are closely pressed together; as in snap-dragon, Antirrhinum majus.

14. Bilabiate (bilabiata), when the corolla has two segments or lips, which lie over against each other, and which are themselves often laciniated or cleft.

15. One-lipped (unilabiata), when in a ringent, personate, &c. corolla, the upper or under lip is wanting, as in Teucrium.

232. The kinds of the many-petalled corolla (corolla polypetala) are,

1. Rose-like (rosacea), when petals which are pretty round, and at their base have no unguis, form a corolla.

2. Mallow-like (malvacea), when five petals, which at the base are considerably attenuated, so unite below that they appear to be monopetalous.

3. Cross-like (cruciata), when four petals, which are very much produced at their base, stand opposite to one another; as in Sinapis alba, Brassica oleracea, viridis, &c.

4. Pink (caryophyllacea), when five petals at their base are much elongated, and stand in a monophyllous calyx; as in Dianthus caryophyllus, &c.

5. Lily-like (liliacea), when there are six petals, but no calyx. In some there are only three, in others they form a tube at the bottom. This makes the idea somewhat indefinite, but it ought to be remarked that this kind of corolla never has a calyx, and that it is only proper to the lilies.

6. Two, three, four, five, many petalled (di-tri-tetra-penta-&c. polypetala), thus the corolla is denominated, according to the number of the petals.

7. Papilionaceous (papilionacea), when four petals differing in figure stand together; to these petals the following names have been given (for instances, examine the flowers of the common pea, pisum sativum, or vetch, vicia sativa):

a. The standard (vexillum) is the uppermost petal, which is commonly the largest, and is somewhat concave.

b. The two wings (alæ) are the two petals, which stand under the vexillum, and opposite to each other on each side.

c. The keel (carina) is the undermost petal; it is hollow, and stands under the vexillum, and opposite to it, and contains the ovary, with the stamina and pistillum.

8. Orchideous (orchidea), is a corolla, composed of five petals, of which the undermost is long, and sometimes cleft; the other four are arched, and bent towards one another.

9. Irregular (irregularis), consisting of four or more petals, which are of different lengths and inclination, so that they do not come under the description of the other kinds.

233. A single division of the corolla, as we have observed, is called a petal (petalum); when this is plain the upper part is called lamina, the under part unguis.

234. The particular parts of the corolla have besides appropriate names. The following are those of the monopetalous corolla :—

1. The tube (tubus) of a monopetalous corolla is the under part, which is hollow, and in general of equal thickness. All flowers with this kind of corolla have a tube, except the bell-shaped, and sometimes the wheel-shaped.

2. The border (limbus), is the opening of the corolla, especially when it is bent back. The limbus is often dentated or deeply divided, and the divisions are called

3. Segments or lobes (laciniæ or lobi), and they are denominated according to their figure, number, and situation.

4. The helmet (galea) is the upper arched lacinia of a ringent or masked corolla, which is further denominated according to its situation, figure, and segments or laciniæ.

5. The gape (rictus) is, in ringent flowers, the space between the two extremities of the helmet and the under lip.

6. The throat (faux), in a monopetalous and ringent corolla, is the opening of the tube.

7. The palate (palatum), in a personate corolla, is the arch of the under lip, which is so elevated as to close the faux.

8. The labellum is the under lip of a ringent and personate corolla.

9. The lips (labia), in the bilabiate and unilabiate flowers, are two divisions, the one called the upper lip (labium superius), and the other the under lip (labium inferius). The galea and labellum are likewise by some botanists called lips.

235. The stamens are the male organs of the plant, and are seated between the corolla and the ovarium. Their parts are three; the filament, the anther, and the pollen.

236. The filament (filamentum) is a longish body, that is destined for the support and elevation of the anther. In its figure it is very various.

1. Capillary (capillare), that is all of equal thickness, and as fine as a hair.

2. Filiform (filiforme), like the former, only thicker.

3. Awl-shaped (subulatum), which is thicker below than above.

4. Dilated (dilatatum), that is so compressed on the sides as to appear broad and leaf-like.

5. Heart-shaped (cordatum), the same with the foregoing, but with a margin above and pointed below; as in Mahernia.

6. Wedge-shaped (cuneiforme), a dilated filament, that is pointed below, but cleft above; as in Lotus tetragonolobus.

7. Loose (liberum), that is not attached to any other filament.

8. Connate (connatum), when several grow together, forming a cylinder; as in the mallow, Malva.

9. Bifid (bifidum), when a filament is divided into two parts.

10. Multifid, or branched (multifidum or ramosum), when it is divided into many branches; as in Carolinea princeps.

11. Jointed (articulatum), when the filament has a moveable joint; as in sage, Salvia officinalis.

12. Connivent (connivens), when several filaments bend towards one another at their points.

13. Incurved (incurvum), that has a bend like a bow.

14. Declined (declinatum), when several filaments do not stand erect, but by degrees, without describing a large curve, bend towards the upper or under part of the flower; as in Pyrola.

15. Hairy (pilosum), set with fine hairs.

16. Equal (æquale), that are all of equal length.

17. Unequal (inæquale), when some are long and some short.

237. The anther (anthera), is a hollow cellular body, that contains a quantity of pollen. Its kinds are the following :—

1. Oblong (oblonga), which is long and pointed at both ends.

2. Linear (linearis), that is long and flat, but all of equal breadth.

3. Spherical (globosa), when perfectly round.

4. Kidney-shaped (reniformis), that is spherical on one side, but concave on the other; as in ground ivy, Glechoma hederacea, fox-glove, Digitalis purpurea, &c.

5. Doubled (didyma), when two seem to be joined together.

6. Arrow-shaped (sagittata), that has a long point, and is cleft at the base into two parts.

7. Bifid (bifida), that is linear, but cleft above and below, as in the grasses.

8. Peltated (peltata), that is circular, flat on both sides, and attached by the middle to the filament; as in the yew, Taxus baccata.

9. Dentated (dentata), that on the margin has dents or indentations; as in the yew, Taxus baccata.

10. Hairy (pilosa), that is covered with hair; as in the dead nettle, Lamium album.

11. Two-horned (bicornis), which has at its apex two subulate prolongations, as in Pyrola, Arbutus, Erica, &c.

12. Awned (aristata), that at the base has two bristle-shaped appendages, as in Erica.

13. Crested (cristata), when two cartilaginous points are set on the sides or on the base; as in some heaths, Ericæ.

14. Awnless (mutica), when it has neither awn nor crest. It is the opposite of No. 12, 13.

15. Angulated (angulata), that has several deep furrows that form four or more angles.

16. Bilocular (bilocularis), when the anther is divided by a partition into two parts or cells.

17. Unilocular (unilocularis), when there is but one cell or cavity in the anther.

18. Bursting at the side (latere dehiscens.)

19. Bursting at the point (apice dehiscens.)

20. Free (libera), that is not attached to another anther.

21. Connate (connata), when several grow together, forming a tube.

22. Erect (erecta), standing with its base straight on the point of the filament.

23. Incumbent (incumbens), that is perpendicularly, or even obliquely, attached to the filament.

24. Lateral (lateralis), that is attached, by its side, to the point of the filament.

25. Moveable (versatilis), when Nos. 23 and 24 are so slightly attached to the filament that the least motion agitates the anther.

26. Adnate (adnata), when the anther is closely attached to both sides of the point of the filament.

27. Sitting (sessilis), that has no filament.

238. The pollen is a powder, that appears in the form of the finest dust. In the microscope its figure is various, being hollow, and filled with a fertilising moisture.

239. The Pistillum is the organ which occupies the centre of the flower, and which finally terminates the development of the inflorescence, just as a bud terminates the progress of the foliage. Hence it has been philosophically considered as a bud in a particular state. It consists of three parts; the ovarium, the style, and the stigma.

240. The Ovarium is the undermost part of the pistillum, and is the rudiment of the future fruit. The number of ovaria is very various; they are reckoned from six to eight, after which they are said to be several or many ovaria. The figure is also very different. The principal kinds are:—

1. Sitting (sessile), that has no foot-stalk.
2. Pedicelled (pedicellatum), furnished with a foot-stalk.
3. Superior (superum), when the germen is encircled by the calyx, or, when this is wanting, by the other parts of the flower.
4. Inferior (inferum), when the ovary is situated under the calyx, or, when this is wanting, under the corolla.

241. The style (stylus), is seated upon the germen, and resembles a small column or stalk. The kinds of it are the following:—

1. Hair-like (capillaris), that is very slender, and of equal thickness.
2. Bristle-like (setaceous), as slender as the former, but somewhat thicker at the base.
3. Thread-like (filiformis), which is long and round.
4. Awl-shaped (subulatus), thick below, above sharp pointed.
5. Gross (crassus), that is very thick and short.
6. Club-shaped (clavatus), thicker above than below.
7. Two, three, four, &c. multifid (bi-tri-quadri-&c., multifidus), cleft in a determined manner.
8. Dichotomous (dichotomus), divided into two parts, which are again divided at the points.
9. Terminal (terminalis), which stands on the top of the germen.
10. Lateral (lateralis), attached to the inside of the germen.
11. Erect (rectus), which stands straight up.
12. Declined (declinatus), that inclines towards the side.
13. Abiding (persistens), that does not fall off
14. Withering (marcescens), that withers and afterwards falls off.
15. Deciduous (deciduus), that falls off immediately after impregnation.

The number of the styles must likewise be accurately counted; for there is often more than one style to one germen, and this must be particularly observed. The length of the style, whether longer or shorter than the stamina, is also to be mentioned.

242. The stigma means the top of the style. The kinds of it are as follows:—

1. Pointed (acutum), when it has a sharp point.
2. Blunt (obtusum), when it forms a blunt point.
3. Oblong (oblongum), when it is thick and elongated.
4. Club-shaped (clavatum), resembling a small club.
5. Spherical (globosum), forming a perfectly round globe.
6. Capitate (capitatum), a hemisphere, the under side flat.
7. Emarginated (emarginatum), when the last-mentioned kind has a notch in it.
8. Peltated (peltatum), that is formed like a shield.
9. Uncinated (uncinatum), hooked at the point.
10. Angular (angulosum), when it is furnished with close and deep furrows, which occasion projecting angles.
11. Three-lobed (trilobum), which consists of three round bodies, somewhat pressed flat.
12. Dentated (dentatum), when it is set with fine teeth.
13. Cruciform (cruciforme), when it is divided into four parts, of which two are always opposite to each other.
14. Pencil-like (pencilliforme), consisting of a number of short, thick, close, fleshy fibres, in form of a pencil.
15. Hollow (concavum), when it is of a globular or longish form, but quite hollow, as in the violet.
16. Petal-like (petaloïdeum), when it has the appearance of a petal; as in Iris.
17. Two, three, and multifid (bi, tri, &c. multifidum).
18. Bent-back (revolutum), when the points of a bifid or multifid stigma are rolled back outwards.
19. Bent in (convolutum), when the points of a divided stigma are rolled inwards.
20. Spiral (spirale), when a multifid stigma is rolled up like the spring of a watch.
21. Plumose (plumosum), when the stigma is set with fine hairs on both sides, so as to have the appearance of a feather; as in the grasses.
22. Hairy (pubescens), that is set with short white hairs.
23. Lateral (laterale), which is situated on the side of the stylus or of the germen.

24. Sitting (sessile), which, when there is no style, rests on the germen.

The stigma, properly speaking, consists of a number of inhaling tubercles, which are not always visible without a magnifier. In the Mirabilis Jalapa they are to be seen most distinctly.

243. The discus is a fleshy ring, surrounding the pistillum at its base; and is one of the various things which Linnæus indiscriminately named nectary. It generally exists in the form of a ring, or annulus, into which the stamens are inserted, or not, as the case may be. Occasionally it is so much enlarged as to enclose the pistillum in part, as in Pæonia Moutan, or entirely, as in Nelumbium, when it constitutes the principal part of the fruit.

244. The fruit is the perfection of vegetation. It is by this part that all plants are perpetuated; and with this, in many plants, existence terminates. In common language, the term is applied to such as are fleshy and eatable; but, in scientific language, it signifies the fecundated ovarium in a ripe state; and, in a more extended sense, the aggregation of several ripe ovaria, even belonging to different flowers.

245. The essential parts of a fruit are the pericarp and the seed.

246. The pericarp is the covering of the seed, and the most external part of the fruit. It is terminated at the one end by the vestiges of the style, and at the other by the receptacle or peduncle. It consists of three parts: 1. the epicarp, which is the skin or outer coat; 2. the sarcocarp, which constitutes the flesh in fleshy fruits, and is the substance immediately covered by the epicarp; 3. the endocarp, which is the inner lining of the fruit, and the same as Gærtner has called putamen.

247. The pericarp is always present in the ovarium, but sometimes is obliterated in the fruit. It is sometimes internally divided by partitions, which are called dissepiments, and which bear on some part of their surface, generally at the inner angle, a fleshy or spongy mass, which is called the placenta, and on which the seeds are placed.

248. The pericarp varies in the mode of dehiscence, in degree of combination, in texture, and in relation to the perianthium. From variations in these modifications, fruits may be divided into five classes, and forty genera, disposed in the following manner:—

Sect. 1. Simple

* Superior.	* Inferior.
1. † Unilocular, or simple.	† Unilocular, or simple.
§ *Indehiscent.*	§ *Indehiscent.*
1. Utriculus.	11. Stephanæum.
2. Achenium.	12. Arcesthida.
3. Cariopsis.	
4. Catoclesium.	
5. Scleranthum.	
6. Samara.	
7. Glans.	
8. Nux.	
9. Drupa.	
10. Lomentum.	

* Superior.	* Inferior.
1. † Unilocular, or simple.	1. † Unilocular, or simple.
§ *Dehiscent.*	
13. Legumen.	
14. Folliculus.	
2. † Plurilocular, or compound.	† Plurilocular, or compound.
§ *Indehiscent.*	§ *Indehiscent.*
15. Nuculanium.	20. Polyachenium.
16. Bacca.	21. Pomum.
17. Hesperidium.	22. Pepo.
18. Carcerulus.	23. Acrosarcum.
19. Sterigmum.	24. Balausta.
§ *Dehiscent.*	§ *Dehiscent.*
25. Siliqua	30. Diplostegia.
26. Silicula.	
27. Pyxidium.	
28. Capsula.	
29. Regmatus.	
3. † Gynobasic.	
31. Microbasis.	
32. Sarcobasis.	
4. † Multiplex.	
33. Acinos.	
34. Etærio.	
35. Amalthea.	
36. Asimina.	
5. † Aggregate.	
37. Sorosus.	
38. Strobilus.	
39. Ananassa.	

249. The foregoing are distinguished among themselves by the following additional characters:—

1. *Utriculus.* Pericarp bladdery monospermous, not adhering to the seed. Eleusine.

2. *Achenium.* Pericarp coriaceous, monospermous, or oligospermous, not adhering to the seed. Rosa. Thecidium of Mirbel is a variety.

3. *Cariopsis.* Pericarp usually thin, monospermous, always adhering closely to the seed and inseparable from it. Grasses. Also called Cerio.

4. *Cataclesium.* Pericarp coriaceous, monospermous, covered by the calyx, which does not adhere to it, but which is much enlarged. Salsola. To this must be referred Sacellus and Sphalerocarpium.

5. *Scleranthum.* Pericarp thin, monospermous, covered by the indurated base of the calyx or perianthium. Mirabilis. Also called Dyclesium.

6. *Samara.* Pericarp coriaceous, oligospermous, with a long wing at its back. Acer. This fruit is either compound or simple, but always unilocular in its divisions.

7. *Glans.* Pericarp coriaceous, mono-dispermous, covered at the base by an indurated involucre, which takes the name of cup. Quercus, Laurus. Also called Calybio.

8. *Nux.* Pericarp woody, mono-dispermous, covered at the base by a foliaceous involucre. Peculiar to Corylus. The term is applied by many authors to nearly all the hard fruits, which

have only one or two seeds. Called also Nucula by Desvaux; but that term is employed by some botanists for the Achenium.

9. *Drupa.* Sarcocarp fleshy; endocarp bony and separable, mono-dispermous. Amygdalus. From this Tryma is not distinguishable.

10. *Lomentum.* Pericarp polyspermous, contracted at the interval between each seed, and separating there into joints. A form of the Legumen. Hedysarum.

11. *Stephanæum.* Pericarp inseparable from the calyx, and of variable consistence, monospermous. Compositæ. Also called Cypsela.

12. *Arcesthida.* Spherical monospermous, formed by the cohesion of several fleshy scales. Juniperus.

13. *Legumen.* Polyspermous, two-valved, one-celled. Vicia.

14. *Folliculus.* Polyspermous, one-valved, often spuriously two-celled. Pæonia.

15. *Nuculanium.* Sarcocarp fleshy, endocarp bony, often confluent. Verbenaceæ. Differs from drupa in being compound. Also called Pyrena and Nucula.

16. *Bacca.* Pericarp pulpy, the cells obliterated, the seeds nidulant in the pulp, and having no distinct mode of connexion with the pericarp when ripe. Jasminum. This term is often applied very vaguely.

17. *Hesperidium.* Sarcocarp coriaceous, endocarp and placentas fleshy or pulpy, seeds nidulant, cells distinct. Citrus. Also called Aurantium.

18. *Carcerulus.* Pericarp dry, cells not more than five, within confluent or distinct. Tilia.

19. *Sterigmum.* Pericarp dry, cells very numerous, more than five, occasionally dehiscent slightly. This is hardly different from the last. Malva.

20. *Polyachenium.* Pericarp and calyx inseparable, dry, cells opposite, separating from the top of the common axis. Umbelliferæ. Called Carpodelium when the cells exceed two, and the pericarp is slightly fleshy; as in Aralia.

21. *Pomum.* Pericarp and calyx inseparable, forming a fleshy mass, endocarp variable in texture, never pulpy. Pyrus.

22. *Pepo.* Pericarp and calyx inseparable, fleshy, endocarp pulpy, seeds parietal, when ripe nidulant in pulp. Cucumis. Also named Peponida.

23. *Acrosarcum.* The same as bacca, but the calyx adheres to the pericarpium. An inferior berry. Ribes.

24. *Balausta.* Pericarp coriaceous, enclosing a number of irregular cells, containing seeds with a pulpy testa. Punica. An inferior Hesperidium.

25. *Siliqua.* Pericarp linear, polyspermous, two-valved, valves separating from the face of the dissepiment. Brassica.

26. *Silicula.* Pericarp round or oblong, oligospermous, two-valved, valves separating from the face of the dissepiment. Draba.

27. *Pyxidium.* Pericarp polyspermous, separating into two halves by a circular horizontal separation, so that the valves resemble two hemispheres. Anagallis. The lower valve is called amphora, the upper operculum.

28. *Capsula.* Pericarp polyspermous, separating vertically into valves. Silene.

29. *Regmatus.* Pericarp separating with elasticity into mono or dispermous cells (cocci), which are pendulous from the apex of a common axis, and are more or less dehiscent. Euphorbia. Scarcely distinct from polyachenium. Also called Cremocarpium.

30. *Diplostegia.* Pericarp polyspermous, variable in consistence, inseparable from the calyx, dehiscing in various manners. May be considered an inferior capsule. Hydrangea.

31. *Microbasis.* Pericarpia several, monospermous, indehiscent, dry, attached by the base to a common style, and seated on a receptacle called the gynobase. Labiatæ. The naked seeds of Linnæus.

32. *Sarcobasis.* A mere variety of the last, from which it scarcely differs, except in having fleshy pericarpia upon an enlarged fleshy gynobase. Ochna.

33. *Acinus.* Drupes, very small and numerous, arranged on an elongated receptacle, and when becoming confluent when ripe, having a membraneous covering. Fragaria. This is the Syncarpa of Richard, but not of others. Polysecus seems to be not distinguishable from this.

34. *Etærio.* Pericarpia several, formed from distinct ovaries, and arranged around an imaginary centre, generally polyspermous and dehiscent. Sempervivum. This is also the Plopocarpium of Desvaux.

36. *Amalthea.* Composed of several achenia, enclosed within the cavity of a coriaceous calyx. Rosa. Also called Cynarrhodon.

37. *Asimina.* Ovaries numerous, bacciform, one-celled, produced from a single flower, and united in a solid fleshy fruit. Anona. Very near the acinus, from which it differs chiefly in size, and in having its outer coat coriaceous, not membranous.

38. *Sorosus.* Pericarpia very numerous, dry, generally achenia, arranged upon a fleshy receptacle, which is urceolate, and enclosed at its mouth. Ficus. Also called Syconus.

39. *Strobilus.* Pericarpia many, indehiscent, unilocular, monospermous, each enclosed in an indurated scale. Scales imbricated, forming by their cohesion a hard irregular cone. Pinus. Of this Galbalus is a mere variety.

40. *Ananassa.* Pericarpia many, indehiscent, polyspermous, cohering with the calyx, and seated each in the axilla of a fleshy scale, which coheres with them, and in maturity forms a solid fleshy mass. Bromelia.

250. The SEED is that part of the fruit which is enclosed in the pericarp, and which contains the rudiments of the future plant. It consists of three distinct parts, the *testa*, the *albumen*, and the *embryo*.

251. The testa is the external covering or coat of the seed. Some writers distinguish it into three parts; calling the external skin the testa, the intermediate substance the sarcodermis, and the interior pellicle the endopleura.

252. The scar upon the testa, which indicates the point by which the seed was attached to the placenta, is called the hilum. On this space two distinct points are observable, viz. the omphalo-

dium, a protuberant point, situated for the most part in the middle of the hilum, and indicating the point by which the nourishing vessels have passed; and the micropyle or foramen, which is a point situated by the side of the umbilicus, and is supposed by some authors to mark the spot by which the fecundating vessels have terminated; but is declared by Mr. Brown to indicate a perforation existing in the ovulum, through which a fecundating aura is communicated to the embryo, and which never has any vascular connexion with the pericarpium.

253. Chalaza is a point marked upon the endopleura, and indicates the place where the umbilical cord pierces it. This point is ordinarily under the hilum; sometimes it is at a distance from it, in which case it is connected with the hilum by a bundle of vessels called the raphe.

254. Strophiolæ are callous or fungous lumps, generally found about the hilum of certain seeds; sometimes they are otherwise stationed.

255. The kernel is the name given to all the parts of the seed included under the testa.

256. The albumen is that part of the kernel which surrounds the embryo, which never adheres to it, which possesses no vascular organisation, and which is of various degrees of texture, being either fleshy, or corneous, or ligneous, or feculent, or granular, &c.

257. The embryo is that part of the kernel which exists in all fecundated seeds, and which is destined to reproduce the plant which bore it. It is divided into three parts, viz. the radicle, the plumula, and the cotyledons.

258. The radicle is that part of the embryo which becomes the root, and which, in the ripe seed, is always directed away from the chalaza.

259. The plumula is the part which is destined to be the stem, and which is situated at the base of the cotyledons.

260. The cotyledons are the organs which adhere to the plumula, and which become the first leaves of the plant. Their purpose is to supply nourishment to the young plant, until it shall be in a condition to elaborate food for itself.

261. The merits and objects of the artificial and natural systems of botany having been already discussed, it now only remains to explain the peculiar details of each, for which purpose, that of Linnæus, as it was left by him and that of Jussieu, as at present received, will suffice.

Linnæan System

262. The classes of this system depend either upon the number, proportion, or insertion, of the stamens or male organs, as explained in the following table:

TABLE of the CLASSES.

Plants celebrate their nuptials.

Either Publicly, i. e. have visible flowers:

Plants, which have visible flowers are either.

Monoclinia, males and females in the same bed: i. e. The flowers are all hermaphrodite:

Among the Monoclinia, there is either

Diffinitas, the males or stamina unconnected with each other:

In these the stamina are either

Indifferentissima, i. e. the males have no fixed proportion as to length:

1. Monandria, i. e. one male or stamen in a hermaphrodite flower.
2. Diandria, . two males or stamina.
3. Triandria, . three males.
4. Tetrandria, . four males.
5. Pentandria, . five males.
6. Hexandria, . six males.
7. Heptandria, . seven males.
8. Octandria, . eight males.
9. Enneandria, nine males.
10. Decandria, . ten males.
11. Dodecandria, twelve males.
12. Icosandria, . twenty, or more males inserted into the calyx.
13. Polyandria, all above twenty males inserted into the receptacle.

Or *Subordinata*, two of the males are uniformly shorter than the rest.

14. Didynamia, . four males, two long and two short.
15. Tetradynamia, six males, four long and two short.

Or Affinitas, the stamina either connected to each other, or to the pistillum.

16. Monadelphia, the stamina united into one body by the filaments.
17. Diadelphia, the stamina united into two bodies by the filaments.
18. Polyadelphia, the stamina united into three or more bodies by the filaments.
19. Syngenesia, the stamina united into a cylindrical form by the antheræ.
20. Gynandria, the stamina inserted into the pistillum.

Or Diclinia, males and females in separate beds: i. e. plants that have stamina and pistilla in different flowers in the same species.

21. Monœcia, male and female flowers distinct in the same plant.
22. Diœcia, males and females in different plants, of the same species.
23. Polygamia, male, female, and hermaphrodite flowers in the same or different plants.

Or Clandestinely, i. e. have their parts of fructification either invisible or not distinct.

24. Cryptogamia, the flowers invisible, so that they cannot be ranked according to the parts of fructification, or distinctly described.

The orders of the first thirteen classes are distinguished by the number of the styles; of the fourteenth by the nature of the fruit, which is what the Linnæan botanists call 'naked seeds' in the first, and 'covered' in the second; of the fifteenth by the length of the pericarpium; of the sixteenth, seventeenth, eighteenth, twentieth, twenty-first, and twenty-second, by the number or situation of the stamens; of the nineteenth by the relative sexes of the florets of the disk, and ray of the capituli; of the twenty-third by the sex of the flowers; and of the twenty-fourth by such general characters as are used in discriminating genera. The following is a

TABLE OF THE ORDERS.

CLASSES.	NUMBER and NAMES of the ORDERS.	
1. Monandria	2	Monogynia, Digynia.
2. Diandria	3	Monogynia, Digynia, Trigynia.
3. Triandria	3	Monogynia, Digynia, Trigynia.
4. Tetrandria	3	Monogynia, Digynia, Tetragynia.
5. Pentandria	6	Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Polygynia.
6. Hexandria	5	Monogynia, Digynia, Trigynia, Tetragynia, Polygynia.
7. Heptandria	4	Monogynia, Digynia, Tetragynia, Heptagynia.
8. Octandria	4	Monogynia, Digynia, Trigynia, Tetragynia.
9. Enneandria	3	Monogynia, Trigynia, Hexagynia.
10. Decandria	5	Monogynia, Digynia, Trigynia, Pentagynia, Decagynia.
11. Dodecandria	5	Monogynia, Digynia, Trigynia, Pentagynia, Dodecagynia
12. Icosandria	5	Monogynia, Digynia, Trigynia, Pentagynia, Polygynia.
13. Polyandria	7	Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Hexagynia, Polygynia.
14. Didynamia	2	Gymnospermia, Angiospermia.
15. Tetradynamia	2	Siliculosa, Siliquosa.
16. Monadelphia	8	Triandria, Pentandria, Octandria, Enneandria, Decandria, Endecandria, Dodecandria, Polyandria.
17. Diadelphia	4	Pentandria, Hexandria, Octandria, Decandria.
18. Polyadelphia	4	Pentandria, Dodecandria, Icosandria, Polyandria.
19. Syngenesia	6	Polygamia æqualis, Polygamia superflua, Polygamia frustranea, Polygamia necessaria, Polygamia segregata, Monogamia.
20. Gynandria	2	Monandria, Diandria.
21. Monœcia	11	Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Heptandria, Polyandria, Monadelphia, Syngenesia, Gynandria.
22. Diœcia	15	Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Octandria, Enneandria, Decandria, Dodecandria, Icosandria, Polyandria, Monadelphia, Syngenesia, Gynandria.
23. Polygamia	3	Monœcia, Diœcia, Triœcia.
24. Cryptogamia	4	Filices, Musci, Algæ, Fungi.

Natural System.

263. The following is the arrangement, adopted by the most modern botanists of reputation, of the natural orders of plants. The basis of it is the system of B. Jussieu, published, in 1789, by his nephew, Anthony Jussieu; but so many alterations and additions have been consequent upon the progress of modern science, that it has at present only a distant resemblance to its original. The best works to be consulted upon the natural system, are, for British plants, Hooker's Flora Scotica; for general botany, the Regni Vegetabilis Systema Naturale of De Candolle, the Prodromus Systematis Naturalis Regni Vegetabilis of the same author, the Nouveaux Elémens de la Botanique of Richard, the Théorie Elémentaire de la Botanique of De Candolle, &c. There is at present (June, 1826,) no English work upon the subject of the natural arrangement of plants which deserves to be consulted.

Table of the Natural Orders of Plants, Arranged in a Linear Series.

I. Vascular or Cotyledoneous. (System furnished with cellular tissue, and tubular vessels Reproductive organs spermaceous.)

* Dicotyledoneous, or Exogenous. (Vessels arranged in concentric layers, of which the youngest are exterior Cotyledons opposite or whorled.)

† Complete. Calyx and corolla, both present.

1. Polypetalous.

§ *Petals hypogynous.*

a. Carpella numerous, or stamens opposite the petals.

i. Ranunculaceæ.
  1. Clematideæ.
  2. Anemoneæ.
  3. Ranunculeæ.
  4. Helleboreæ.
  5. Pæoniaceæ.

ii. Dilleniaceæ.
  1. Delimeæ.
  2. Dilleneæ.

iii. Magnoliaceæ.
  1. Illicieæ.
  2. Magnolieæ.

iv. Anonaceæ.

v. Menispermaceæ.
  1. Lardizabaleæ.
  2. Menispermeæ.
  3. Schizandreæ.

vi. Berberideæ.

vii. Podophyllaceæ.
1. Podophylleæ.
2. Hydropeltideæ.
viii. Nymphæaceæ.
1. Nelumboneæ.
2. Nymphæeæ.

β. Carpella solitary or consolidated; Placentas parietal.

ix. Papaveraceæ.
x. Fumariaceæ.
xi. Cruciferæ.
1. Arabideæ.
2. Alyssineæ.
3. Thlaspideæ.
4. Euclidieæ.
5. Anastaticeæ.
6. Cakilineæ.
7. Sisymbreæ.
8. Camelineæ
9. Lepidineæ.
10. Isatideæ.
11. Archonieæ.
12. Brassiceæ.
13. Velleæ.
14. Psychineæ.
15. Zilleæ.
16. Raphaneæ.
17. Buniadeæ.
18. Erucarieæ.
19. Heliophileæ.
20. Subularieæ.
21. Brachycarpeæ.
xii. Capparideæ.
1. Cleomeæ.
2. Cappareæ.
xiii. Resedaceæ.
xiv. Flacourtianeæ.
1. Patrisieæ.
2. Flacourtieæ.
3. Kiggelarieæ.
4. Erythrospermeæ.
xv. Bixineæ.
xvi. Cistineæ.
xvii. Violarieæ
1. Violeæ.
2. Alsodineæ.
3. Sauvageæ.
xviii. Droseraceæ.
xix. Polygaleæ.
xx. Tremandreæ.
xxi. Pittosporæe.
xxii. Frankeniaceæ.

γ. Ovary solitary. Placenta central.

xxiii. Caryophylleæ.
1. Sileneæ.
2. Alsineæ.
xxiv. Lineæ.
xxv. Malvaceæ.
xxvi. Byttneriaceæ.
1. Sterculieæ.
2. Byttnerieæ.
3. Lasiopetaleæ.
4. Hermannieæ.
5. Dombeyaceæ.
6. Wallichieæ.
xxvii. Tiliaceæ.
xxviii. Elæocarpeæ.
xxix. Chlenaceæ.
xxx. Ternströmiaceæ.
1. Ternströmieæ.
2. Frezierieæ.
3. Sauraveæ.
4. Laplaceæ.
5. Gordonieæ.
xxxi. Camellieæ.
xxxii. Olacineæ.
xxxiii. Aurantiaceæ
xxxiv. Hypericineæ
1. Vismieæ.
2. Hypericeæ.
xxxv. Guttiferæ.
1. Clusieæ.
2. Garcinieæ.
3. Calophylleæ.
4. Symphonieæ.
xxxvi. Marcgraaveaceæ.
1. Marcgraavieæ.
2. Noranteæ.
xxxvii. Hippocrateaceæ.
xxxviii. Erythroxyleæ.
xxxix. Malpighiaceæ.
1. Malpighieæ.
2. Hiptageæ.
3. Banisterieæ.
x.. Acerineæ.
xli. Hippocastaneæ.
xlii. Rhizoboleæ.
xliii. Sapindaceæ.
. Paullinieæ.
. Sapindeæ.
3. Dodonæaceæ.
xliv. Meliaceæ.
1. Melieæ.
2. Trichilieæ.
3. Cedreleæ.
xlv. Ampelideæ.
1. Viniferæ.
2. Leeaceæ.
xlvi. Geraniaceæ.
xlvii. Tropæoleæ.
xlviii. Balsamineæ.
xlix. Oxalideæ.
l. Zygophylleæ
li. Rutaceæ.
1. Diosmeæ.
2. Cusparieæ.
lii. Coriarieæ.

δ. Fruit gynobasic.

liii. Simarubeæ.
liv. Ochnaceæ.

§§. Petals, either separated or united, always perigynous.

lv. Celastrineæ.
1. Staphylæceæ.
2. Euonymeæ.
3. Aquifoliaceæ.
lvi. Rhamneæ.
lvii. Bruniaceæ.
lviii. Samydeæ.
lix. Homalineæ.
lx. Chailletiaceæ.
lxi. Aquilarineæ.
lxii. Terebintaceæ.
1. Cassuvieæ.
2. Sumachineæ.
3. Spondiaceæ

4. Burseraceæ.
5. Amyrideæ.
6. Pteleaceæ.
7. Connaraceæ.

lxiii. Leguminosæ
1. Sophoreæ.
2. Loteæ.
3. Hedysareæ.
4. Vicieæ.
5. Phaseoleæ.
6. Dalbergieæ.
7. Swartzieæ.
8. Mimoseæ.
9. Geoffreæ.
10. Cassieæ.
11. Detarieæ.

lxiv. Rosaceæ.
1. Chrysobalaneæ.
2. Amygdaleæ.
3. Spiræaceæ.
4. Neuradeæ.
5. Dryadeæ.
6. Roseæ.
7. Pomaceæ.

lxv. Salicarieæ.
lxvi. Tamariscinæ.
lxvii. Melastomaceæ.
lxviii. Myrtaceæ.
lxix. Combretaceæ.
lxx. Cucurbitaceæ.
lxxi. Passifloreæ.
lxxii. Loaseæ.
lxxiii. Onagrariæ.
lxxiv. Ficoideæ.
lxxv. Paronychiæ.
lxxvi. Portulaceæ.
lxxvii. Cacteæ.
lxxviii. Grossulaceæ.
lxxix. Crassulaceæ.
lxxx. Saxifrageæ.
lxxxi. Cunoniaceæ.
lxxxii. Umbelliferæ.
1. Hydrocotylineæ.
2. Bupleurineæ.
3. Pimpinelleæ.
4. Smyrnieæ.
5. Caucalineæ.
6. Scandicineæ.
7. Ammineæ.
8. Selineæ.

lxxxiii. Araliaceæ.
lxxxiv. Caprifoliaceæ.
lxxxv. Lorantheæ.
lxxxvi. Hamamelideæ.
lxxxvii. Rubiaceæ.
lxxxviii. Opercularieæ.
lxxxix. Valerianeæ.
xc. Dipsaceæ.
xci. Calycereæ.
xcii. Compositæ.
1. Lactuceæ.
2. Carlineæ.
3. Centaurieæ.
4. Carduineæ.
5. Echinopseæ.
6. Arctotideæ.
7. Calenduleæ.
8. Tagetineæ.
9. Heliantheæ.
10. Ambrosieæ.
11. Anthemideæ.
12. Inuleæ.
13. Astereæ.
14. Senecioneæ.
15. Nassauvieæ.
16. Mutisieæ.
17. Tussilagineæ.
18. Adenostyleæ.
19. Eupatorieæ.
20. Vernonieæ.

xciii. Campanulaceæ.
xciv. Lobeliaceæ.
xcv. Gesnerieæ.
xcvi. Vaccinieæ.
xcvii. Ericeæ.
xcviii. Monotropeæ.

§ § § *Petals combined in an hypogynous corolla.*

xcix. Myrsineæ.
c. Sapoteæ.
ci. Ebenaceæ.
cii. Oleineæ.
ciii. Jasmineæ.
civ. Strychneæ.
cv. Apocyneæ.
cvi. Gentianeæ.
cvii. Bignoniaceæ.
cviii. Sesameæ.
cix. Polemoniaceæ.
cx. Convolvulaceæ.
cxi. Boragineæ.
cxii. Hydrophylleæ.
cxiii. Cordiaceæ.
cxiv. Solaneæ.
cxv. Scrophularineæ.
1. Antirrhineæ.
2. Rhinanthaceæ.
3. Melampyraceæ.

cxvi. Myoporineæ.
cxvii. Pedalineæ.
cxviii. Labiatæ.
cxix. Verbenaceæ.
cxx. Acanthaceæ.
cxxi. Lentibulariæ.
cxxii. Primulaceæ.
cxxiii. Globularineæ.

† † Incomplete.—*Calyx and corolla confounded.*

cxxiv. Plumbagineæ.
cxxv. Plantagineæ.
cxxvi. Nyctagineæ.
cxxvii. Amarantaceæ.
cxxviii. Chenopodeæ.
cxxix. Begoniaceæ.
cxxx. Polygoneæ.
cxxxi. Laurineæ.
cxxxii. Myristiceæ.
cxxxiii. Proteaceæ.
cxxxiv. Penæaceæ.
cxxxv. Thymelææ.
cxxxvi. Santalaceæ.
cxxxvii. Elæagneæ.
cxxxviii. Aristolochiæ.
cxxxix. Euphorbiaceæ.
cxl. Calycantheæ.
cxli. Monimieæ.
cxlii. Urticeæ.
cxliii. Piperaceæ.

cxliv. Chloranthеæ.
cxlv. Amentaceæ.
1. Ulmaceæ.
2. Salicineæ.
cxlvi. Casuarineæ.
cxlvii. Coniferæ.

** Monocotyledoneous, or Endogenous.—(Vessels disposed in parcels, of which the youngest are in the centre. Cotyledons solitary, or alternate, or absent).

† Phænogamous. Fructification visible or regular.

cxlviii. Cycadeæ.
cxlix. Hydrocharideæ.
cl. Alismaceæ.
cli. Orchideæ.
1. Neottieæ.
2. Arethuseæ.
3. Gastrodieæ.
4. Ophrydeæ.
5. Vandeæ.
6. Epidendreæ.
7. Malaxideæ.
8. Cypripedieæ.
clii. Scitamineæ.
cliii. Maranteæ.
cliv. Bromeliæ.
clv. Irideæ.
clvi. Hypoxideæ.
clvii. Hæmodoraceæ.
clviii. Amaryllideæ.
clix. Hemerocallideæ.
clx. Liliaceæ.
clxi. Melanthaceæ.
clxii. Dioscoreæ.
clxiii. Smilaceæ.
clxiv. Asphodeleæ.
clxv. Junceæ.
clxvi. Butomeæ.
clxvii. Restiaceæ.
clxviii. Eriocauleæ.
clxix. Commelineæ.
clxx. Pontedereæ.
clxxi. Palmæ.
clxxii. Pandaneæ.
clxxiii. Aroideæ.
clxxiv. Typhineæ.
clxxv. Fluviales.
clxxvi. Juncagineæ.
clxxvii. Pistiaceæ.
clxxviii. Cyperaceæ.
1. Cypereæ.
2. Scirpeæ.
3. Sclerineæ.
4. Caricineæ.
clxxix. Gramineæ.
1. Paniceæ.
2. Stipaceæ.
3. Agrostideæ.
4. Bromeæ.
5. Chlorideæ.
6. Cereales.
7. Sacchariueæ.
8. Oryzeæ.
9. Bambusaceæ.

†† Cryptogamous. Fructification unknown or irregular.
clxxx. Filices.
1. Polypodiaceæ
2. Osmundaceæ.
3. Ophioglosseæ.
clxxxi. Equisetaceæ.
clxxxii. Lycopodineæ.
clxxxiii. Marsileaceæ.

II. Cellular, or Acotyledonous. (System composed of cellular tissue without tubular vessels. Reproductive organs gemmaceous.
clxxxiv. Musci.
clxxxv. Hepaticæ.
clxxxvi. Algæ.
1. Diatomeæ.
2. Nostochineæ
3. Confervoideæ.
4. Ulvaceæ.
5. Florideæ.
6. Fucoideæ.
clxxvii. Lichens.
1. Idiothalami.
2. Cænothalami.
3. Homothalami.
4. Athalami.
5. Pseudo-lichenes
clxxxviii. Fungi.
1. Hymenomycetes.
2. Gasteromycetes.
3. Hyphomycetes.
4. Coniomycetes.

264. Abbreviations.

☿ A hermaphrodite flower.
♂ A male flower.
♀ A female flower.
♂—♀ Male and female flowers upon one stem (flores monoici).
♂ : ♀ Male and female flowers on different stems (flores dioici).
♄ Neuter flowers (flores neutri).
☿ | ♀ Hermaphrodite and female flowers in one compound flower (flores hermaphroditi et feminei); as in the class syngenesia.
☿ | ♄ Hermaphrodite and neuter flowers in one compound flower (flores hermaphroditi et neutri), in the same class.
☿—♂ Hermaphrodite and male flowers on one stem (flores polygami.)
☿—♀ Hermaphrodite and female flowers on one stem (flowers polygami).

⊙ Annual, ♂ Biennial, ♃ Herbaceous, ♄ Shrubby, ◡ Climbing,	In writing of the habits of plants.

! Affixed to the citation of an author, shows that an authentic specimen has been examined.
⁎ Affixed in like manner shows that the work quoted contains a good description of the subject.
† Indicates something doubtful.
v. v. Seen alive.
v. s.——dried.
sp.—— in a wild state.
c.—— in a cultivated state.

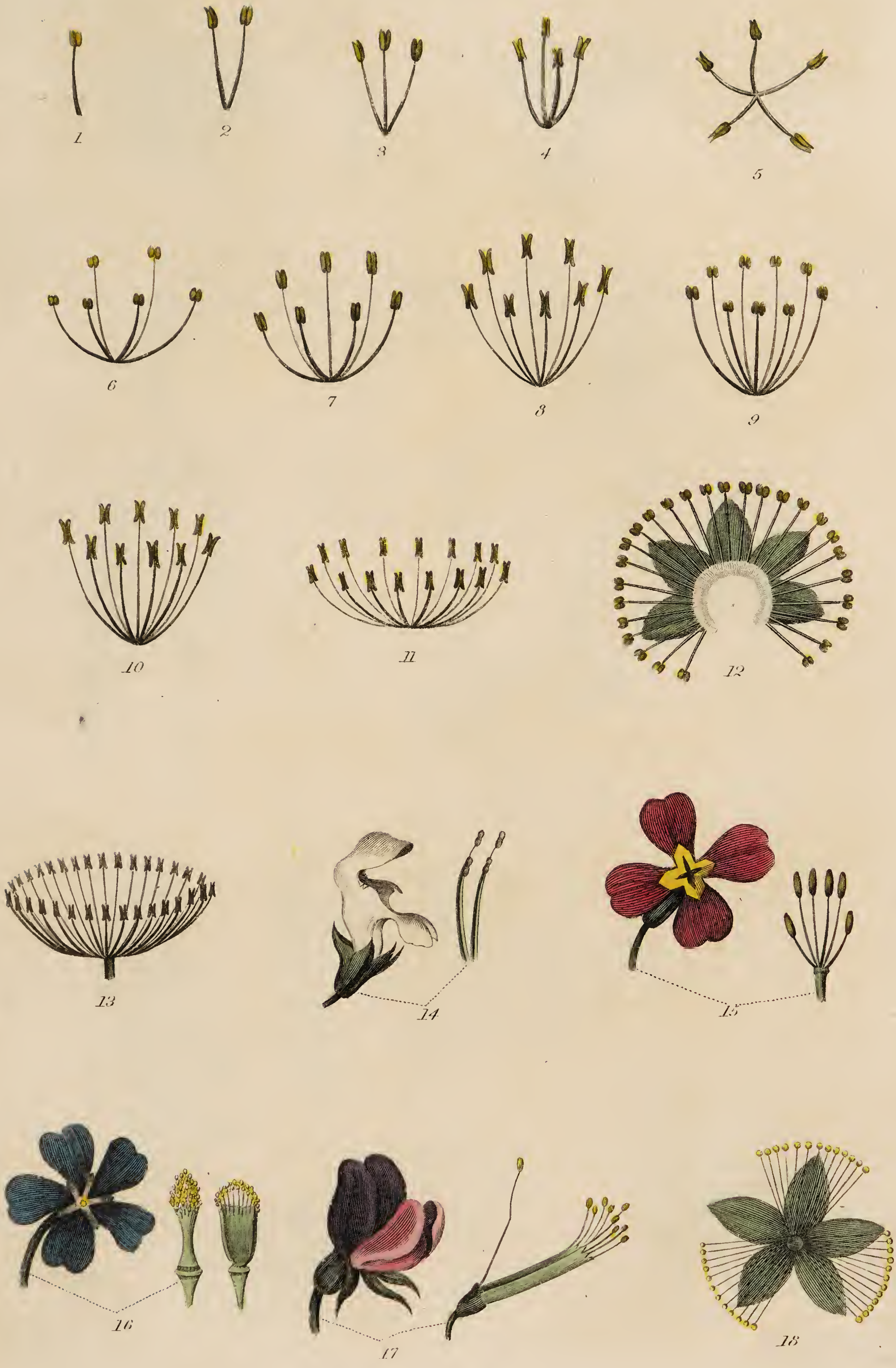
INDEX.

PLATE I.

BOTANY.

LINNEAN SYSTEM.

Classes.



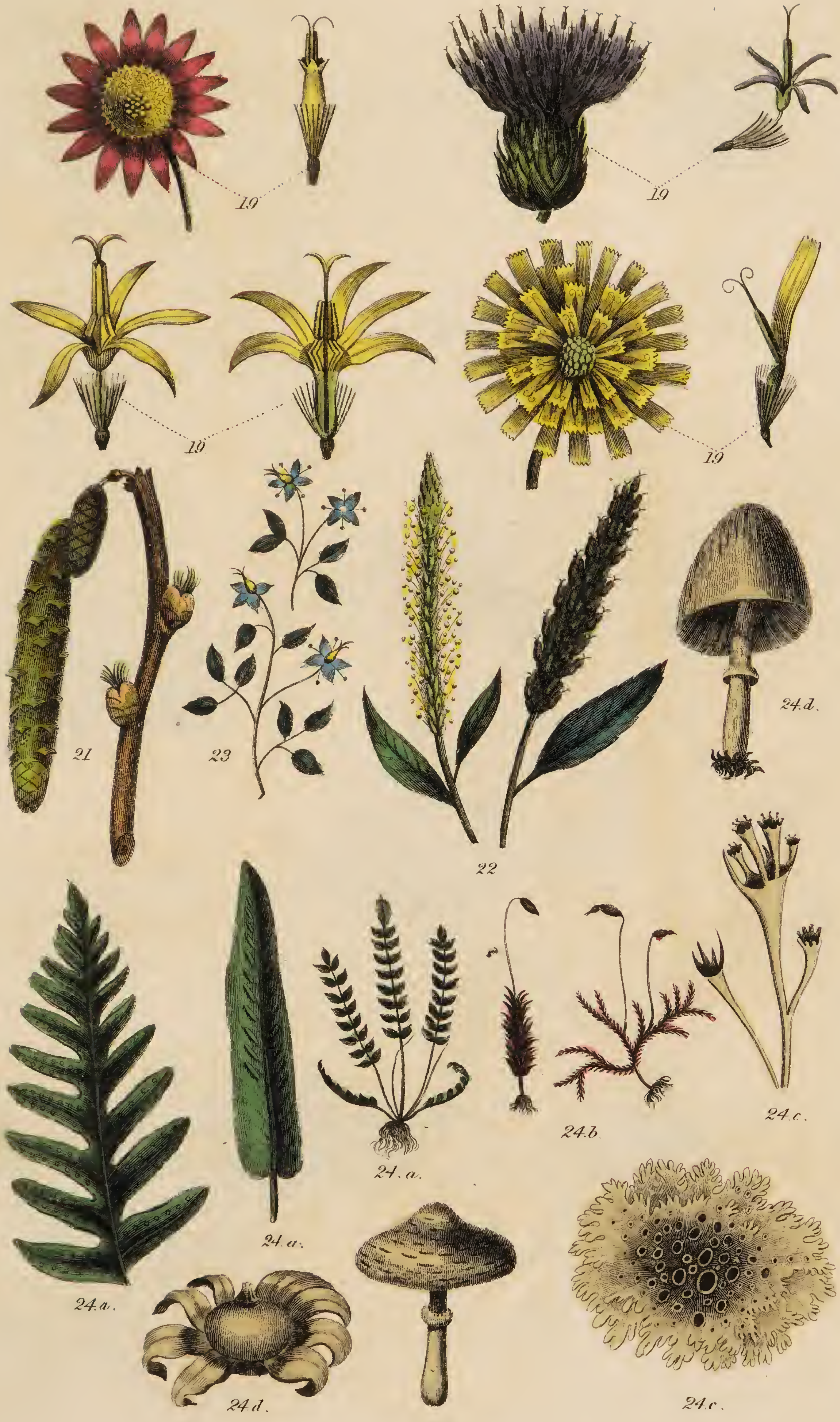
J. Shury, sc.

London, Published by Thomas Tegg, 73 Cheapside, Sept. 1, 1826.

BOTANY.

LINNEAN SYSTEM.

Classes.



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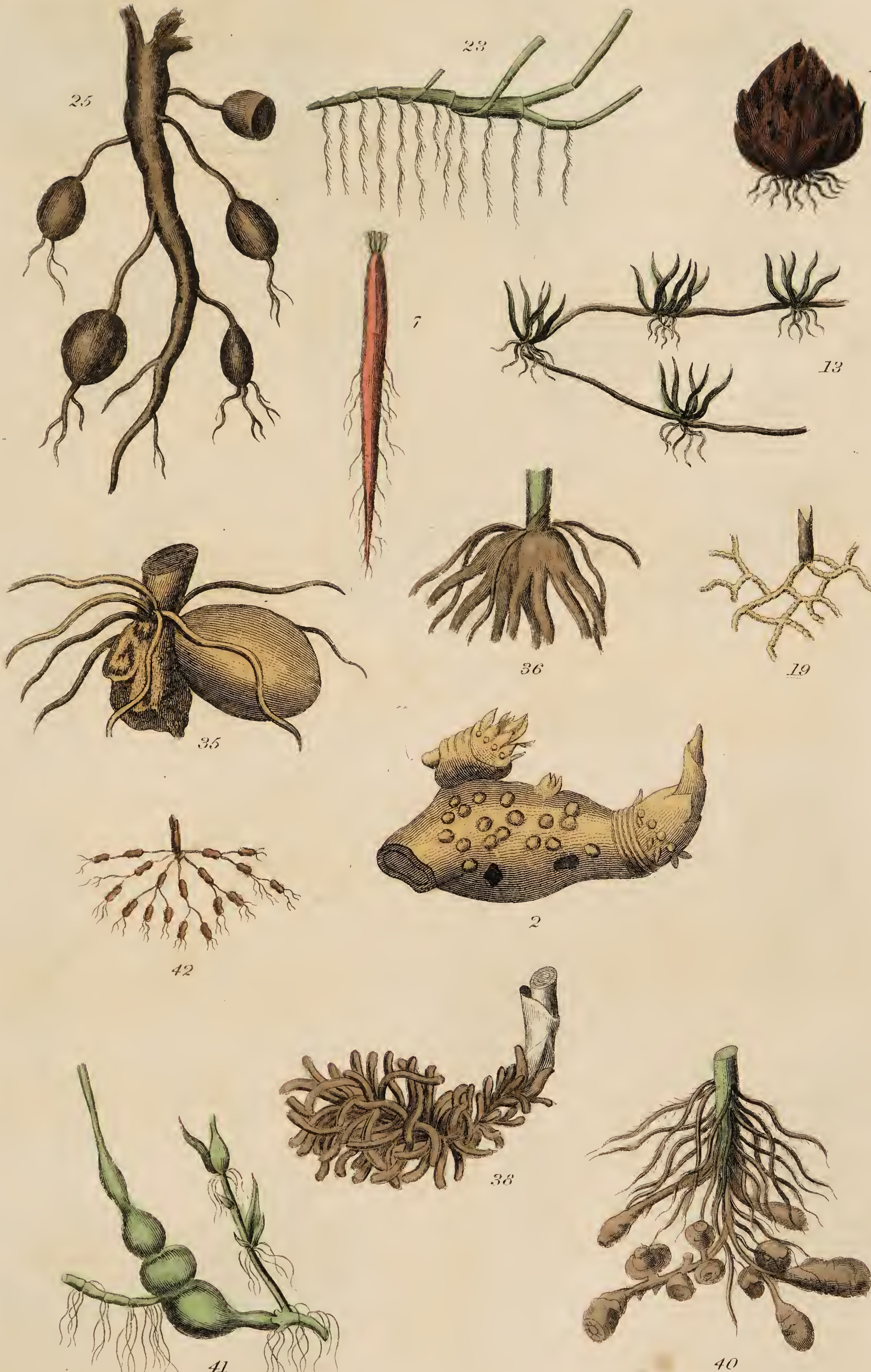
BOTANY.

Roots.



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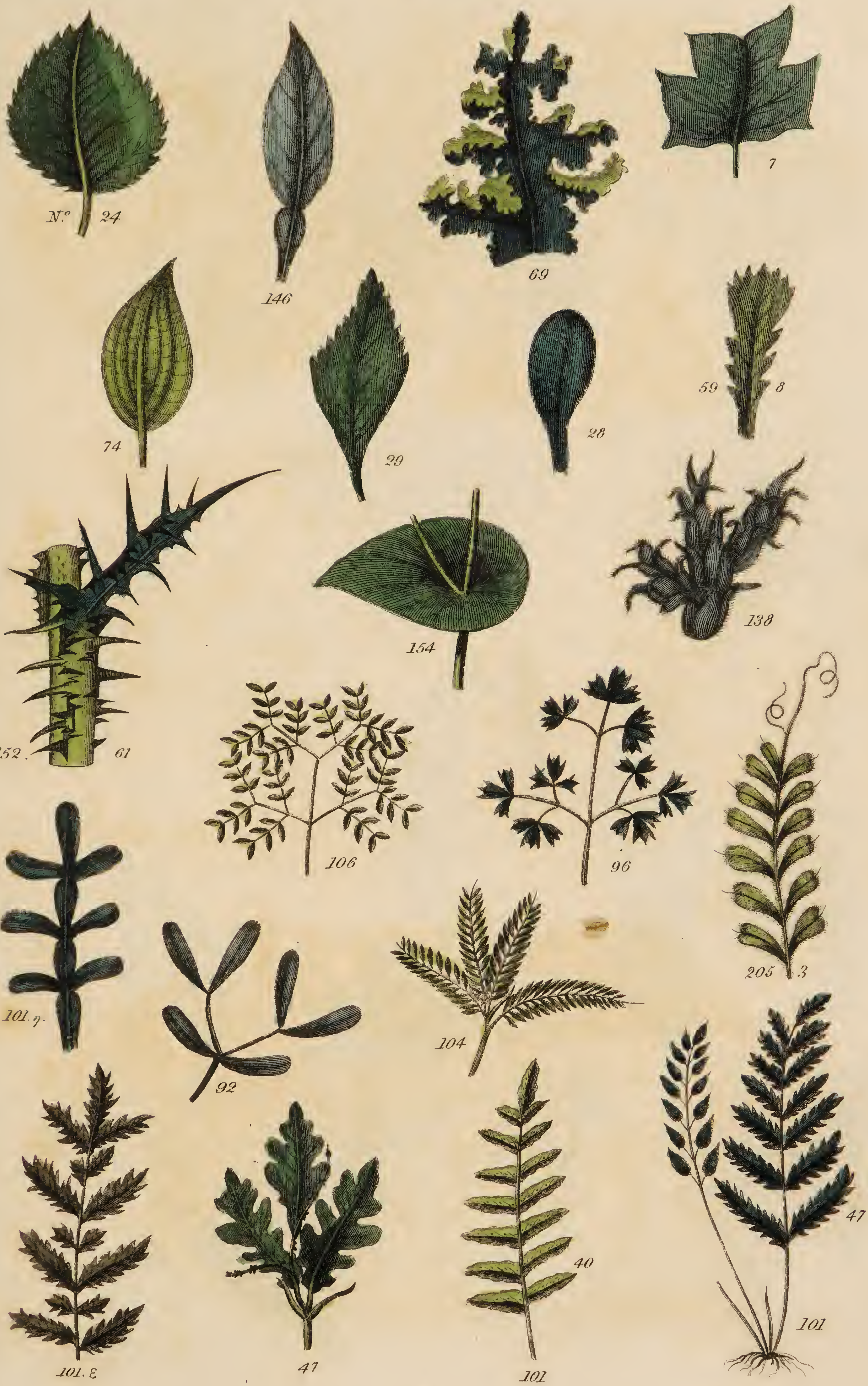
BOTANY. PLATE IV.

Leaves.



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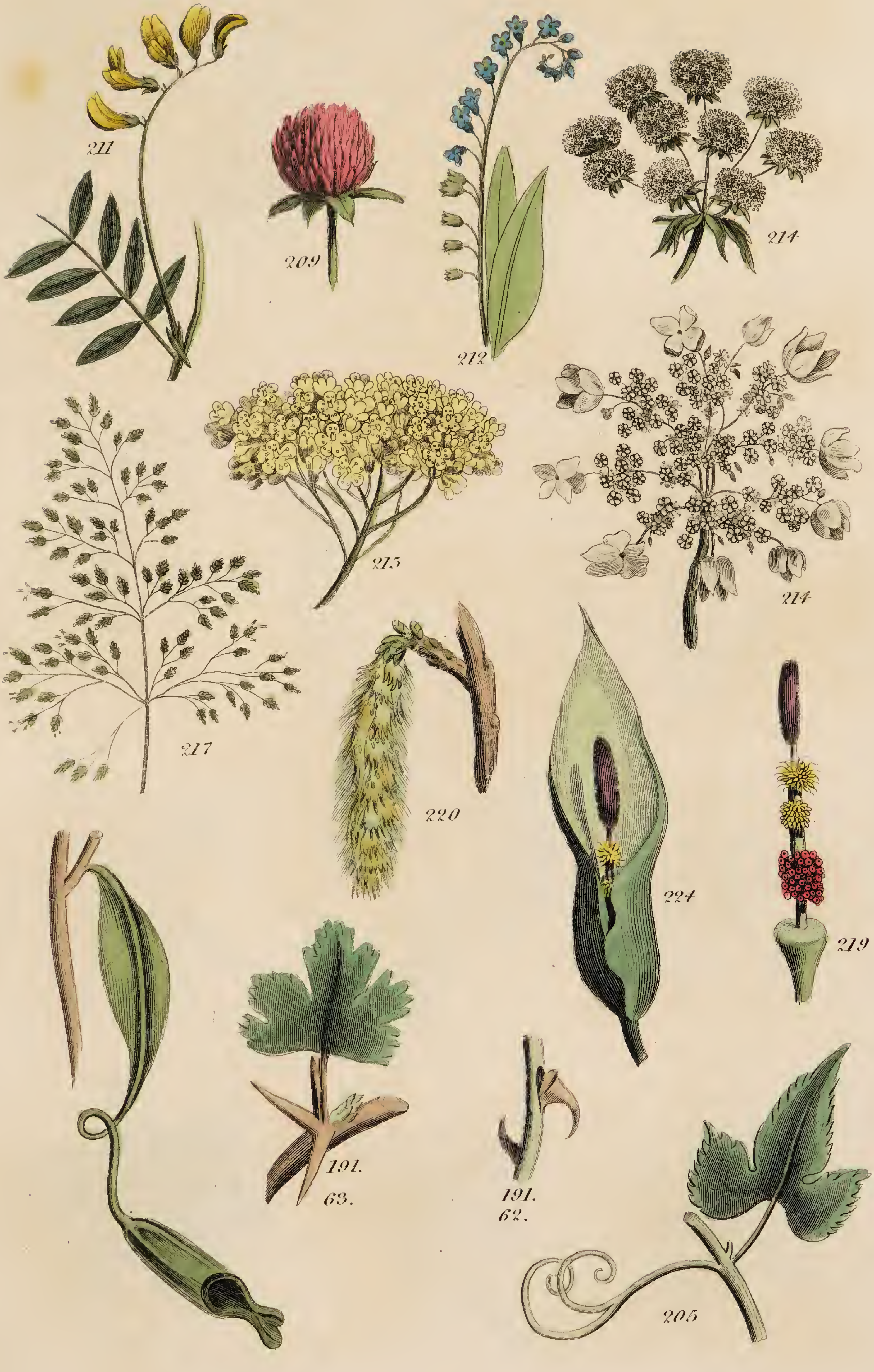
Inflorescence.



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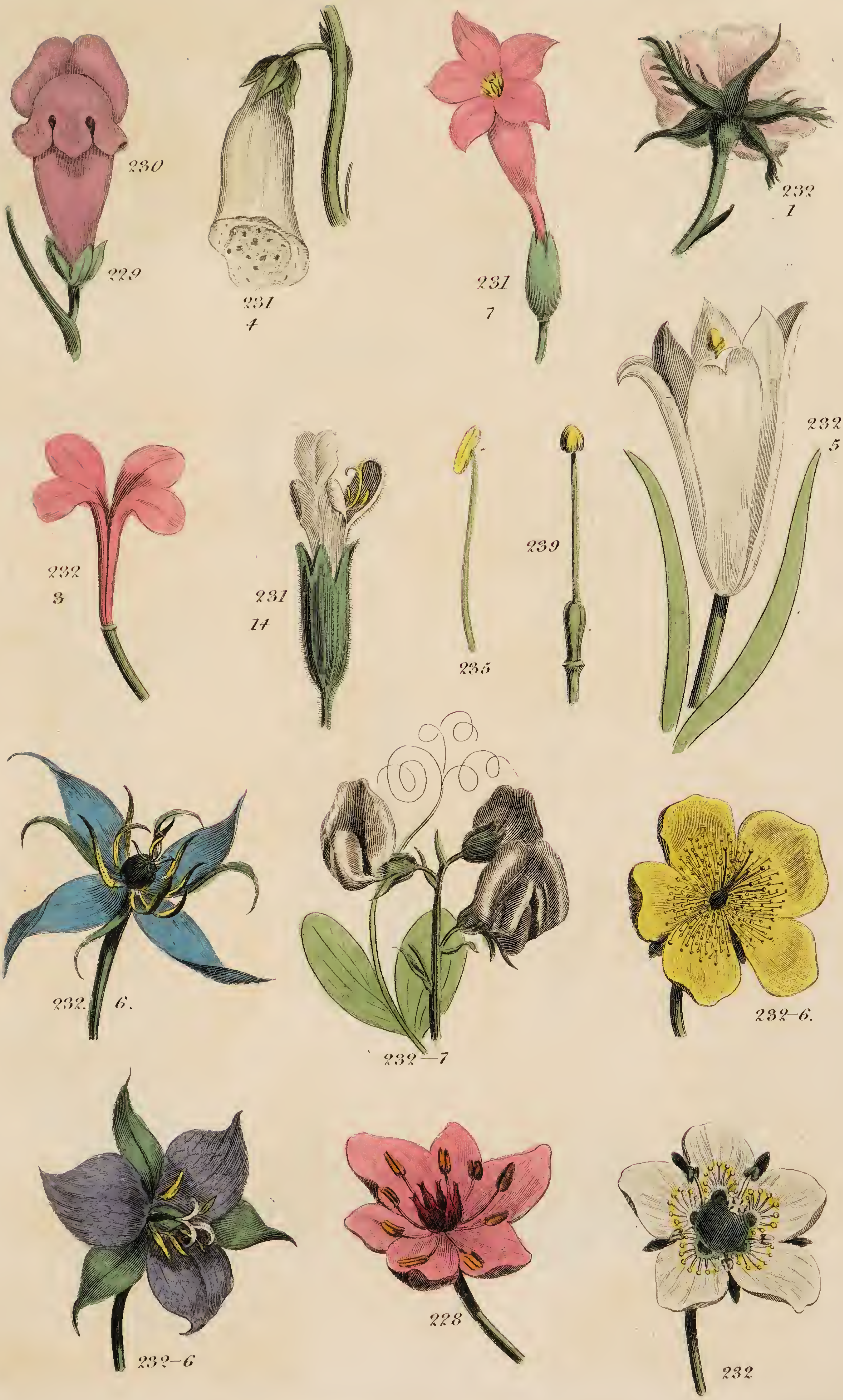
Flowers.



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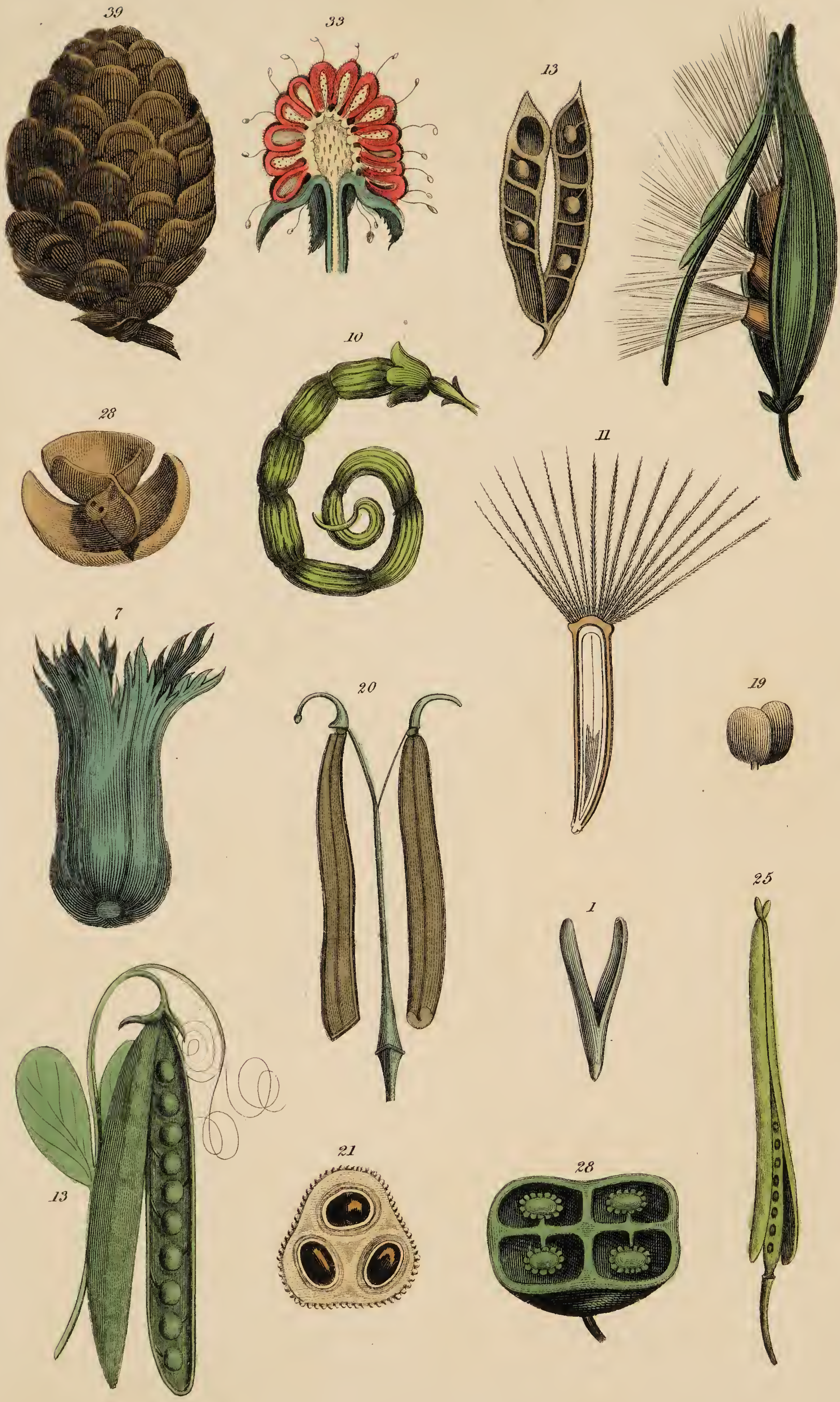
BOTANY.



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